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EDWIN DUNKIN, F.R.S., President, in the Chair.

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Walter Claude Johnson, Mem. Inst. C.E., 8 Vanbrugh Park, Blackheath, S.E.;

Richard Wilding, Sunny Bank, Victoria Road, Fulwood, Preston,

were balloted for and duly elected Fellows of the Society.

On the Term of Long Period due to Mars in the Expression for the Longitude of the Moon. By Edmund Neison.

In the last volume of the *Memoirs* (vol. xlviii., Part II. p. 419), there is a paper by M. Gogou, containing a calculation of the value of the term of long period in the expression for the longitude of the Moon, arising from the disturbing action of *Mars*, together with a lengthy criticism of my own merely provisional calculations published in the *Monthly Notices* for November 1877 (vol. xxxviii. pp. 49–53).

M. Gogou finds a result differing much from mine, and this difference he considers due to three things:

I. Because I employ strictly undisturbed elliptic coordinates of the Moon instead of coordinates partially modified by the action of the Sun.

II. Because there are errors in the expression assigned by me to the disturbing function.

III. Because I have omitted a number of small terms which have been retained by him.

Practically the whole *Memoir* is devoted to supplying these deficiencies, so some comment on my part seems called for.

It should be borne in mind that the calculation so elaborately criticised by M. Gogou in his eighteen pages of the *Memoirs* was a mere first provisional calculation occupying just three pages of the *Notices*, a calculation stated at the time to be a mere provisional approximation needing revision and extension, as well as the inclusion of the higher powers of the disturbing forces.

My reply to M. Gogou's criticism is short and direct.

I. I employed the strictly undisturbed values of the elliptic coordinates of the Moon, because, as expressly stated, my calculation was confined to the part of the co-efficient depending on the first power of the disturbing forces.

By introducing a few terms nominally independent of m, M. Gogou has vitiated the accuracy of his results, for these terms, though independent, by a mere convention, of m, do all the same depend on the disturbing power of the Sun; and if the effects of the disturbing action of the Sun is to be introduced at all, it must be introduced throughout and not only in part, and must include the terms explicitly depending on m as well as the terms which merely implicitly depend on m.

II. M. Gogou shows that there are errors in the expression assigned by me to the disturbing function on page 52 of my original note. This is true; in two places a is printed for a^2, and in one case a is printed for $2a$. But a glance at the previous steps ought to have shown M. Gogou that these are purely printer's errors of not the slightest importance, as they do not exist in the calculations themselves. The very symmetry of the previous expansions might have shown this to M. Gogou, and thus saved him compiling an elaborate memoir to rectify some printer's omissions.

III. The reason why I omitted the terms forming M. Gogou's expression R., is expressly stated in my original note, because they were so small as to be insensible (p. 51, lines 10–12). All that M. Gogou has done has been to show by an elaborate calculation that I am perfectly correct—they are absolutely insensible. I did not deem a calculation necessary, as the result was so obvious.

It is true, that according to M. Gogou, the more important portion of the co-efficient, that calculated by me, yields results no larger than this other. But even were this really the case, it does not show, as M. Gogou seems to think, that I ought to have elaborately calculated both, but merely that I need not have calculated either.

It is not too much to say that nine-tenths of this memoir of M. Gogou's is devoted to the elaborate calculation of small terms which could not possibly be of the smallest importance, being, as

already pointed out by me, so small as to be completely insensible. And all that this part of M. Gogou's memoir does is to prove the correctness of this statement of mine. The remainder consist merely of a somewhat more detailed expression for the terms calculated by me, but with this difference, as pointed out in my note in the *Monthly Notices* for March 1885 (vol. xlv. pp. 326–328), that my calculations are more complete than those of M. Gogou. This note in the *Monthly Notices* for March, deals with the only real issue between us, and the entire memoir of M. Gogou is utterly beside the question, being devoted to the elaborate calculation of a mass of small terms, which we both agree in finding completely insensible.

My own memoir on this subject, like all the rest of my scientific work, was brought to a complete standstill by long severe illness throughout the entire summer; and though slowly recovering, I fear their publication will all be seriously delayed, as it will be some time yet ere I can return to the mathematical work.

The Observatory, Natal:
1885, *Nov.* 9.

Comparison of Groombridge's and Struve's Right Ascensions of Close Circumpolar Stars. By Truman Henry Safford.

Groombridge's Catalogue of Circumpolar Stars is so important, and in many respects excellent, that its positions ought to be improved as far as possible. The attempt has been made to do this by the application of systematic corrections; but those in Right Ascension are hardly well enough known for the region immediately about the North Pole.

The correction usually employed is Argelander's

$$+0^{s}\cdot06 + 0^{\circ}\cdot12 \tan\delta.$$

which is derived from the previous investigations of Struve and Fedorenko, combined with his own.

Struve's hypothesis is that Groombridge's meridian mark was about $3''$ in error; but the comparisons which I give in the present paper will show that this may not be altogether certain, at least for the earlier period (1806–1809), when Groombridge was especially observing the closer polars.

Within 10° of the Pole there are few stars with which comparison has been made between Groombridge and later observers. In order to fill this gap, I have compared his catalogue with the Dorpat Right Ascensions observed by W. Struve in 1814 and 1815. In this I have employed only Struve's Catalogus I., which contains the closer stars, and have confined myself to the region north of $+70°$. The results are as follows:—

Zone +86° to +90°.

No. Groombridge.	Polar Distance.	$\Delta\alpha$ Struve-Groombridge.	$\Delta\alpha \cos\delta$.
	°	s	s
144	2·0	− 1·82	−0·06
235	1·7	+ 0·40	+0·01
642	4·0	− 1·14	−0·08
1119	0·9	−12·05	−0·20
1141	2·7	− 3·73	−0·18
1850	3·4	+ 1·09	+0·06
1871	2·5	− 0·67	−0·03
1884	1·3	− 0·93	−0·02
2006	1·4	+ 3·29	+0·08
2065	1·5	+11·8	+0·31
2099	3·4	+ 3·71	+0·22
2210	3·3	+ 3·88	+0·22
2283	2·1	+ 1·63	+0·06
2628	3·4	+ 0·07	0·00
2667	3·1	+ 0·45	+0·02
3308	1·3	+ 1·83	+0·04
3548	3·7	+ 0·88	+0·06
4101	3·7	− 0·35	−0·02

Zone +83° to +86°.

No. Groombridge.	Polar Distance.	$\Delta\alpha$ Struve-Groombridge.	$\Delta\alpha \cos\delta$.
	°	s	s
67	4·7	+0·79	+0·06
177	4·8	+0·20	+0·02
595	5·8	+2·49	+0·25
750	5·0	+0·47	+0·04
766	6·7	+0·44	+0·05
944	4·9	−0·83	−0·07
956	4·8	+2·63	+0·22
1359	5·4	−5·56	−0·53
1418	4·3	−5·72	−0·43
1620	4·8	+0·47	+0·04
1633	6·5	−0·33	−0·04
1889	5·3	+2·91	+0·27
1937	5·6	+1·15	+0·11
1940	5·6	+1·76	+0·17
2007	4·3	+1·12	+0·09

No. Groombridge.	Polar Distance.	Δα Struve-Groombridge.	Δα cos δ.
	°	s	s
2063	6·3	+1·24	+0·14
2196	6·7	+1·25	+0·15
2213	5·3	+1·98	+0·16
2315	6·5	+0·83	+0·09
2476	6·6	+0·56	+0·06
2548	6·6	−2·10	−0·24
3501	6·5	−0·30	−0 03
3820	4·8	+0·33	+0·03
3824	4·7	−0·47	−0·04
3970	6·6	−0·45	−0·05
4193	4·3	+0·20	+0·02

Zone 80° to 83°.

No. Groombridge.	Polar Distance.	Δα Struve-Groombridge.	Δα cos δ.
	°	s	s
424	9·6	+0·94	+0·16
426	9·4	+1·28	+0·21
506	9·2	−0·03	0·00
527	9·4	+0·67	+0·11
580	9·3	+0·58	+0·09
746	9·8	−0·05	−0·01
774	7·1	+0·43	+0·05
779	9·6	+0·47	+0·08
785	9·5	+0·52	+0·09
856	9·1	+0·99	+0·16
1255	8·4	−1·17	−0·17
1259	7·3	+0·54	+0·07
1278	8·8	−0·49	−0·07
1339	9·3	−0·50	−0·08
1355	9·7	+0·56	+0·09
1391	7·0	−0·85	−0·10
1431	7·1	−1·81	−0·22
1452	9·3	−0·56	−0·00
1463	9·3	−0·83	−0·13
1480	8·5	−0·08	−0·01
1537	7·9	−1·46	−0·20
1643	8·6	−0·85	−0·13
1662	8·6	−0·36	−0·05
1778	7·9	+1·01	+0·14

No. Groombridge.	Polar Distance.	$\Delta\alpha$ Struve-Groombridge.	$\Delta\alpha \cos\delta$.
	°	s	s
1782	7·9	−0·07	−0·01
1845	8·1	+1·86	+0·26
1858	7·3	−0·13	−0·02
1909	8·7	+1·31	+0·20
1927	8·4	+1·34	+0·19
1977	8·5	+0·15	+0·02
2037	8·7	+0·05	+0·01
2071	8·3	+0·80	+0·12
2275	9·0	+1·93	+0·30
2276	9·0	+2·06	+0·32
2422	7·7	+0·29	+0·04
2456	9·7	+0·23	+0·04
3268	9·2	+0·40	+0·06
3276	9·2	+0·43	+0·07
3277	9·6	+0·33	+0·05
3370	8·2	+0·85	+0·12
3707	8·4	+0·23	+0·03
3709	8·4	+0·79	+0·12
3887	9·6	−0·10	−0·03
3928	7·8	−0·30	−0·04

Zone 70° to 80°.

No. Groombridge.	Polar Distance.	$\Delta\alpha$ Struve-Groombridge.	$\Delta\alpha \cos\delta$.
	°	s	s
616	13·0	+0·53	+0·12
919	11·0	+0·71	+0·14
966	15·1	+0·69	+0·18
1217	12·8	+0·63	+0·14
1562	10·0	−0·71	−0·12
1650	13·3	+0·98	+0·23
1859	11·4	+0·58	+0·11
2094	11·6	+0·10	+0·02
2130	13·5	+0·21	+0·05
2172	15·1	+0·65	+0·17
2228	17·5	−0·09	−0·03
2236	17·5	+0·55	+0·17
2268	12·0	+1·46	+0·31
2294	11·6	+1·39	+0·28

No. Groombridge.	Polar Distance.	$\Delta\alpha$ Struve-Groombridge.	$\Delta\alpha \cos\delta$.
	°	s	s
2334	13·7	+0·28	+0·07
2336	14·3	−0·69	−0·17
2349	13·8	+0·67	+0·16
2475	17·8	0·00	0·00
2477	17·8	−0·06	−0·02
2546	10·0	[−4·92]	
2547	10·0	[−4·98]	
2726	14·8	+0·08	+0·02
2930	16·0	+0·43	+0·12
3148	12·9	+0·43	+0·10
3373	10·1	−1·16	−0·20
3419	12·6	+0·16	+0·04
3508	14·4	−0·75	−0·19
3511	10·3	+1·74	+0·31
3809	12·2	−0·71	−0·15
3831	12·1	−0·82	−0·17
3834	14·7	−0·74	−0·19
4122	13·4	−0·04	−0·01

The stars connected by braces are components of pretty close doubles; the comparison has been made by using Groombridge's precessions reduced to Struve; the secular variations of the Radcliffe Catalogue, and the best proper motions attainable, either those of the *Fundamental Catalogue* of the *Berliner Jahrbuch*, those of Albrecht, or my own published or unpublished results. No error of any consequence has arisen from the occasional use of rather rough values, as the interval is everywhere less than nine years.

It will be seen on taking the means that the values of $\Delta\alpha \cos\delta$ vary but little with the declination, but are subject to rather large casual errors.

The mean value of $\Delta\alpha \cos\delta$ is $= +0^s{\cdot}034 \pm 0^s{\cdot}009$, and the probable error of the result from one star $= \pm 0^s{\cdot}093$ by sums of errors.

This is too large a quantity to be accounted for by the ordinary errors of observation. A liberal allowance for them in Struve's cases is $\pm 0^s{\cdot}03$ to $\pm 0^s{\cdot}04$, leaving at least $\pm 0^s{\cdot}084 = \sqrt{(0{\cdot}093)^2 - (0{\cdot}04)^2}$ for Groombridge. In one case, the double star 40 and 41 *Draconis*, the discrepancy arises from a mistake in Groombridge's reduction, as both stars are largely in error in his catalogue; and the stars *Groombridge* 1359 and 1418 are also suspicious; in both these cases Struve has three observations, and is confirmed by Schwerd and later authorities.

A small part of the visible periodicity is due to the use of an erroneous nutation-constant; but I think there is but little doubt that the main cause of discrepancy is instrumental error. Groombridge's meridian mark was rather too near—about half a mile, if the map of London, contained in Baedeker's guide-book, is trustworthy—and a previous investigation of Maskelyne's and Pond's observations has shown me that a polar deviation (Bessel's n) of $\pm 1''$ is not altogether to be avoided when the instrument is adjusted to the Meridian from time to time, and left for days to its own motions, without allowing for azimuth and level error in the modern fashion.

Singularly enough, the constant correction here indicated ($+0^s{\cdot}034 \sec \delta$ or $+0^s{\cdot}034 \tan \delta$, very nearly the same thing) is but little more than would be derived from the observations of *Polaris* between June 23, 1806, and April 27, 1807, as given on p. xiii. of the Catalogue. The mean of the six double transits gives—

Excess of lower—upper culminations $= +2^s{\cdot}05$, and this multiplied by one-half the cotangent of the star's declination gives $+0^s{\cdot}03$ for the value of Bessel's n, or the polar deviation.

But these northern stars were mainly observed in 1806, 1807, and 1808. There is some difference between Struve's observations of 1814 and 1815, and those made later by himself and Argelander, which seem to be of the nature of personal equation. The comparison of all Groombridge's stars below 80°, which can be found in the later catalogues mentioned, gives $+0^s{\cdot}12$ for the coefficient of $\tan \delta$, instead of $+0^s{\cdot}035$. I do not think that any definite conclusion can be arrived at as to the real meaning of this term until it shall be possible to subject Groombridge's Right Ascensions to a careful revision with respect to signs of instrumental deviation.

This should not be a difficult task, employing his manuscripts, but would be greatly aided if their main portions were printed, as the original observations of Piazzi have been, so that any who were desirous to study them could have the opportunity.

There is no doubt, I think, that Groombridge's work deserves nearly as much attention in future ages as does Bradley's, allowance being made for the limited region in which he chiefly laboured; and I am quite sure that a careful revision of his results would repay the trouble spent on it in a great variety of directions.

At present it is almost impossible to obtain absolutely definitive values for the proper motions of the closer polars without very arbitrary assumptions as to the weight and systematic correction of Groombridge; and even the best ephemerides of these stars are in places quite uncertain, owing to the lack of trustworthy proper motions.

On the Reduction of Bessel's Precessions to those of Struve.

By A. A. Rambaut.

(*Communicated by Prof. R. S. Ball.*)

In the *Monthly Notices*, vol. xxxix. p. 364, Prof. Krueger has given a formula for reducing the annual precessions of Bessel to those of Struve, and Prof. Auwers has given tables in the *Fundamental Catalogue* containing corrections to Bessel's secular variations. Prof. Krueger's tables for the precessions in Right Ascension I have merely transcribed here, in order to have them along with the other tables, but I have put the corrections to the precessions in Declination in what appears to me a more convenient form. Prof. Auwers' tables are for reducing Bessel's secular variations for the year 1860, to those of Struve for 1875, whereas the object of this paper is to reduce the precessions, and secular variations of the precessions, according to Bessel, for any year, to their values as derived from Struve's constants for the same year. That this is not quite the same thing will appear from a comparison of the tables which follow with those of Prof. Auwers.

Let capital letters denote the values of the constants at the beginning of the century, and let those with B subscript refer to Bessel, and those with S subscript to Struve.

Then

$$m_B = M_B + m'_B.t = 46''04367 + 0''0003086450 \cdot t$$
$$m_S = M_S + m'_S.t = 46{\cdot}0623 \; + 0{\cdot}0002849 \, .t$$
$$n_B = N_B + n'_B.t = 20{\cdot}05957 - 0{\cdot}0000970204 \, .t$$
$$n_S = N_S + n'_S.t = 20{\cdot}0607 \; - 0{\cdot}0000863 \, .t$$

Then the annual precession according to Bessel (P_B).

$$= \tfrac{1}{15} m_B + \tfrac{1}{15} n_B \tan \delta \sin \alpha$$

And

$$P_S = \tfrac{1}{15} m_S + \tfrac{1}{15} n_S \tan \delta \sin \alpha$$

therefore

$$P_S - P_B = \tfrac{1}{15} \cdot \frac{m_S n_B - m_B n_S}{n_B} + \frac{n_S - n_B}{n_B} P_B = k + l P_B .$$

The factor l being at its greatest equal to 0·00010823, it is sufficient to take P_B to two places of decimals in this equation to obtain the result correct to five.

The values of k and l for every tenth year during the century, which are given in Table I., are taken from Prof. Krueger's paper in the *Monthly Notices*, correcting an evident misprint which has occurred in the latter.

Again, Bessel's precession in declination (Q_B)

$$Q_B = n_B \cos \alpha, \text{ and } Q_S = n_S \cos \alpha,$$

whence

$$Q_S - Q_B = (n_S - n_B) \cos \alpha.$$

The values of this are given in Table II. for every tenth year during the century, and for every hour of Right Ascension in units of the fourth decimal. They are always of the same sign as Q_B.

The secular variation in α is

$$P' = \tfrac{100}{15}\left(m' + \frac{n^2}{2K} \sin 2\alpha\right) + \tfrac{100}{15}\left(n' \sin \alpha + \frac{mn}{K} \cos \alpha\right) \tan \delta$$

$$+ \tfrac{100}{15} \frac{n^2}{K} \sin 2\alpha \tan^2 \delta,$$

where

$$K = 206265,$$

or

$$P' = A + B \tan \delta + C \tan^2 \delta.$$

Therefore

$$P'_S - P'_B = (A_S - A_B) + (B_S - B_B) \tan \delta + (C_S - C_B) \tan^2 \delta.$$

Also the secular variation in δ is

$$Q' = 100\left(n \cos \alpha - \frac{mn}{K} \sin \alpha\right) - \frac{100}{K} n^2 \sin^2 \alpha \tan \delta = A' + B' \tan \delta,$$

and therefore

$$Q'_S - Q'_B = (A'_S - A'_B) + (B'_S - B'_B) \tan \delta.$$

We have

$$A_S - A_B = \tfrac{100}{15}\left\{ m'_S - m'_B + \frac{1}{2K}(n_S^2 - n_B^2) \sin 2\alpha \right\}.$$

From the values given above we find

$$\tfrac{100}{15}(m'_S - m'_B) = -0^s.0001583.$$

Also

$$\frac{100}{30K}\left\{ n_S^2 - n_B^2 \right\} = \frac{100}{30K}\left\{ N_S^2 - N_B^2 + 2(N_S n'_S - N_B n'_B)t + \left(n'^2_S - n'^2_B \right) t^2 \right\}$$

The last term in this is quite inappreciable, and we find

$$\frac{100}{30K}\left(N_S^2 - N_B^2 \right) = +0^s.0000006,$$

and

$$\frac{100}{15K}\left(N_S n'_S - N_B n'_B\right) = +0{\cdot}0000000069,$$

whence during the century

$$A_S - A_B = -0^s{\cdot}000158.$$

Again

$$A'_S - A'_B = 100\left\{(n'_S - n'_B)\cos\alpha - \frac{m_S n_S - m_B n_B}{K}\sin\alpha\right\},$$

and we have

$$100(n'_S - n'_B) = +0{\cdot}00107.$$

Also

$$\frac{100}{K}\left\{m_S n_S - m_B n_B\right\} = \frac{100}{K}\left\{M_S N_S - M_B N_B) + (m'_S N_S - m'_B N_B + M_S n'_S - M_B n'_B)t + (m'_S n'_S - m'_B n'_B)t^2\right\}.$$

The third term in this is also inappreciable, and we find

$$m'_S N_S - m'_B N_B = -0{\cdot}0004759923,$$

and

$$M_S n'_S - M_B n'_B = +0{\cdot}0004919990,$$

and therefore

$$m'_S N_S - m'_B N_B + M_S n'_S - M_B n'_B = +0{\cdot}0000160067,$$

whence it is clear that the coefficient of sin α in the value of

$$A'_S - A'_B \text{ is } \frac{100}{K}\left(M_S N_S - M_B N_B\right) = +0{\cdot}00020642.$$

Thus we have

$$A'_S - A'_B = (10{\cdot}7\cos\alpha - 2{\cdot}064\sin\alpha)$$

in units of the fourth decimal.

The values of this correction for every hour of Right Ascension are given in Table III.

The value of $A'_S - A'_B$ in seconds of arc for any value of α is fifteen times that of $B_S - B_B$ in seconds of time for $\alpha + 6^h$. Thus we obtain the correction to B_B from the following table, which is immediately deducible from Table III.

h	B_S-B_B	h	h	B_S-B_B	h	h	B_S-B_B	h
0	+1·4	12	4	+6·9	16	8	+5·5	20
1	+3·2	13	5	+7·2	17	9	+4·1	21
2	+4·8	14	6	+7·1	18	10	+2·4	22
3	+6·0	15	7	+6·5	19	11	+0·5	23
						12	−1·4	24

Between 12^h and 24^h take the correction with an opposite sign. The correction is given in units of the fifth decimal. Table IV. gives the value of this multiplied by $\tan\delta$.

It remains to find the values of C_S-C_B and of $B'_S-B'_B$.

We have

$$C_S-C_B=\frac{100}{15K}\left(n_S{}^2-n_B{}^2\right)\sin 2\alpha$$

$$=\left\{+0^s\cdot0000012+0^s\cdot00000000138\,.\,t\right\}\sin 2\alpha.$$

Although this term is very small, yet being multiplied by $\tan^2\delta$, it has an effect on stars whose declinations exceed 50°. In Table V. are given the values of the coefficient of $\sin 2\alpha$ for every tenth year, and in Table VI. the values of $\sin 2\alpha\tan^2\delta$. The product of these two quantities, along with the number taken from Table IV., and the constant $-0^s\cdot000158$, gives the whole correction to the secular variation of the precession in α.

Again

$$B'_S-B'_B=-\frac{100}{K}\left(n_S{}^2-n_B{}^2\right)\sin^2\alpha$$

$$=-(0''\cdot000018+0''\cdot000000207\,.\,t)\sin^2\alpha,$$

this multiplied by $\tan\delta$, if $t=100$ and $\alpha=6^h$, does not amount to $0''\cdot0001$, as long as δ is less than 69°, and as its greatest value—for 80°—within the limits of these tables is $0''\cdot00022$, it may be safely neglected. We have thus the whole correction to Q_B from Table III. in units of fourth decimal.

If, however, it be thought necessary to correct for this term, the numerical coefficient is given in Table VII. for every twentieth year during the century, and the corresponding factor in Table VIII. The whole correction, then, to the secular variation of the precession in δ, in units of the fourth decimal, is the number taken from Table III., along with the product of those taken from Tables VII. and VIII.

Example—

$$\alpha=20^h\ 24^m\ 27^s\cdot5, \qquad \delta=-10°\ 20'\ 41''$$

for 1855.

The annual precession in α with Bessel's constants $= + 3^{s}\cdot26785$

" " δ " " $= + 11''\cdot8200$

Secular variation of the precesssion in α $= -0^{s}\cdot00785$

" " " δ $= +0''\cdot3793$

From Table I. we find for 1855

$$k = 0\cdot000895 \text{ and } l = 0\cdot0000842.$$

We have then

$$\begin{aligned} P_B &= + 3\cdot26785 \\ 3\cdot27 \times 0\cdot0000842 &= \quad 275 \\ k &= \quad 895 \\ P_S &= + 3\cdot26902 \end{aligned}$$

Also

$$\begin{aligned} Q_B &= + 11\cdot8200 \\ \text{Correction from Table III.} &= \quad 10 \\ Q_S &= + 11\cdot8210 \end{aligned}$$

Again,

$$\begin{aligned} P'_B &= - 0\cdot00785 \\ \text{Correction from Table IV.} &= + \quad 09 \\ \text{" " Tables V. and VI.} &= \quad 00 \\ A_S - A_B &= - \quad 158 \\ &- 0\cdot00800 \end{aligned}$$

And, finally,

$$\begin{aligned} Q'_B &= + 0\cdot3793 \\ \text{Correction from Table III.} &= + \quad 79 \\ Q'_S &= + 0\cdot3801 \end{aligned}$$

In order to show the difference between these tables and those of Prof. Auwers, in the *Fundamental Catalogue*, let us compare the secular variations in α of a star for which $\alpha = 3^{h}$ and $\delta = 78°$ for 1875.

By direct calculation we find

$$P'_S = + 0^{s}\cdot393557 \text{ and } P'_B = + 0^{s}\cdot393376.$$

$$\begin{aligned} \text{The correction from Table IV.} &= + 28\cdot3 \\ \text{" from Tables V. and VI.} &= + \quad 5\cdot1 \\ A_S - A_B &= - 15\cdot8 \\ &+ 17\cdot6 \end{aligned}$$

Which would give $P'_S = 0^{s}\cdot393552$. Prof. Auwers' correction is 14·2, which would make $P'_S = 0^{s}\cdot393518$.

Table I.

	k	l		k	l		k	l
1800	+0·00107	+0·00005484	1840	+0·00094	+0·00007619	1880	+0·00081	+0·00009755
1810	0·00104	0·00006018	1850	0·00091	0·00008153	1890	0·00078	0·00010289
1820	0·00101	0·00006551	1860	0·00088	0·00008687	1900	0·00075	0·00010823
1830	0·00098	0·00007085	1870	0·00085	0·00009221			

Table II.

α	1800.	1810.	1820.	1830.	1840.	1850.	1860.	1870.	1880.	1890.	1900.	α
0^h or 24^h	11·3	12·4	13·4	14·5	15·6	16·7	17·7	18·8	19·9	20·9	22·0	12^h or 12^h
1 „ 23	10·9	12·0	12·9	14·0	15·1	16·1	17·1	18·2	19·2	20·2	21·3	13 „ 11
2 „ 22	9·8	10·7	11·6	12·6	13·5	14·5	15·3	16·3	17·2	18·1	19·1	14 „ 10
3 „ 21	8·0	8·8	9·5	10·3	11·0	11·8	12·5	13·3	14·1	14·8	15·6	15 „ 9
4 „ 20	5·6	6·2	6·7	7·2	7·8	8·3	8·8	9·4	10·0	10·5	11·0	16 „ 8
5 „ 19	2·9	3·2	3·5	3·8	4·0	4·3	4·6	4·9	5·2	5·4	5·7	17 „ 7
6 „ 18	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	18 „ 6

Table III.

α	Correction.	α	α	Correction.	α	α	Correction.	α	α	Correction.	α
0^h	+10·7	12^h	4^h	+3·6	16^h	7^h	−4·8	19^h	10^h	−10·3	22^h
1	+ 9·8	13	5	+0·8	17	8	−7·1	20	11	−10·9	23
2	+ 8·2	14	6	−2·1	18	9	−9·0	21	12	−10·7	24
3	+ 6·1	15									

Betweeen 12^h and 24^h take the correction with an opposite sign.

Table IV.

		0°	10°	20°	30°	40°	50°	60°	65°	70°	72°	74°	76°	78°	80°		
0^h	+	0·0	0·2	0·5	0·8	1·2	1·6	2·4	2·9	3·8	4·	4·8	5·5	6·5	7·8	−	12^h
1	+	0·0	0·6	1·2	1·8	2·7	3·8	5·5	6·8	8·7	9·8	11	12·7	14·9	18·0	−	13
2	+	0·0	0·8	1·7	2·8	4·0	5·7	8·2	10·2	13·1	14·6	16·6	19·1	22·4	27·0	−	14
3	+	0·0	1·1	2·2	3·5	5·1	7·2	10·4	12·9	16·5	18·5	21·0	24·1	28·3	34·1	−	15
4	+	0·0	1·2	2·5	4·0	5·8	8·2	11·9	14·7	18·9	21·2	24·0	27·5	32·3	39·0	−	16
5	+	0·0	1·3	2·6	4·2	6·1	8·6	12·6	15·5	19·9	22·3	25·3	29·1	34·0	41·1	−	17
6	+	0·0	1·3	2·6	4·1	6·0	8·5	12·4	15·3	19·6	22·0	24·9	28·6	33·5	40·4	−	18
7	+	0·0	1·1	2·4	3·8	5·5	7·8	11·3	14·0	18·0	20·1	22·8	26·2	30·7	37·1	−	19
8	+	0·0	1·0	2·0	3·2	4·6	6·5	9·5	11·8	15·1	16·9	19·2	22·0	25·8	31·1	−	20
9	+	0·0	0·7	1·5	2·4	3·4	4·8	7·1	8·7	11·2	12·5	14·2	16·3	19·1	23·1	−	21
10	+	0·0	0·4	0·9	1·4	2·0	2·8	4·1	5·1	6·5	7·3	8·3	9·5	11·1	13·4	−	22
11	+	0·0	0·1	0·2	0·3	0·4	0·6	0·9	1·1	1·4	1·6	1·8	2·1	2·4	3·0	−	23
12	−	0·0	0·2	0·5	0·8	1·2	1·6	2·4	2·9	3·8	4·2	4·8	5·5	6·5	7·8	+	24

The signs in the second column are for North, and those in the second last column for South Declinations and Right Ascensions between 0^h and 12^h. Between 12^h and 24^h take the correction with an opposite sign.

TABLE V.

1800	0·12	1840	0·18	1880	0·23
1810	0·13	1850	0·19	1890	0·24
1820	0·15	1860	0·20	1900	0·26
1830	0·16	1870	0·22		

Units of fifth decimal.

TABLE VI.

h	m	55°	60°	64°	68°	70°	72°	74°	76°	78°	80°
0	0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
	30	0·5	0·8	1·1	1·6	2·0	2·5	3·2	4·2	5·7	8·3
1	0	1·0	1·5	2·1	3·1	3·8	4·7	6·1	8·0	11·0	16·1
	30	1·4	2·1	3·0	4·3	5·3	6·7	8·6	11·4	15·6	22·7
2	0	1·8	2·6	3·6	5·3	6·6	8·2	10·6	13·9	19·1	27·8
	30	2·0	2·9	4·1	5·9	7·3	9·2	11·8	15·3	21·4	32·0
3	0	2·0	3·0	4·2	6·1	7·6	9·5	12·2	16·1	22·1	32·1

The correction for $6^h - \alpha =$ + the correction for α.

" " " 6 $+\alpha =$ − " " " "

" " " 12 $+\alpha =$ + " " " "

TABLE VII.

1800	0·18	1840	0·26	1880	0·35
1820	0·22	1860	0·31	1900	0·39

TABLE VIII.

	55°	60°	65°	70°	75°	80°	
0^h or 24^h	0·0	0·0	0·0	0·0	0·0	0·0	12^h or 12^h
1 " 23	0·1	0·1	0·1	0·2	0·2	0·4	11 " 13
2 " 22	0·4	0·4	0·5	0·7	0·9	1·4	10 " 14
3 " 21	0·7	0·9	1·1	1·4	1·9	2·8	9 " 15
4 " 20	1·1	1·3	1·6	2·1	2·8	4·2	8 " 16
5 " 19	1·3	1·6	2·0	2·6	3·5	5·3	7 " 17
6 " 18	1·4	1·7	2·2	2·8	3·7	5·7	6 " 18

For North Declinations the factor is negative, and positive for South.

Dunsink:

1885, *Dec.* 10.

Observations of Double Stars at Windsor, New South Wales.

By John Tebbutt.

The accompanying table contains the results of all the double-star observations made by me to the present date. The $4\frac{1}{2}$-inch Equatorial was employed throughout, but it was not driven by clockwork. The steadiness and uniform motion of the slow motion arrangement in Right Ascension were very satisfactory. The greatest difficulty in the work of observation consisted in the measurement of distances when the position angle approached 90° or 270°, but it will be seen that these conditions seldom occurred.

Name of Star.	Observed Magnitudes.	Approx. place at beginning of Year of Observation. R.A. h m	Declin. South. ° ′	Year, Month, and Day of Observation.	Fraction of Year.	Position Angle.	Distance.	No. of Measures. Position.	No. of Measures. Distance.	Weight of Result.	Magnifying Power.	Obs. E. or W. of Merid.	Ref. No. to Remarks.
β Toucani	—	0 26·1	63 37	1882 Mar. 18	·21	170°·4	27″·32	8	7	3	180	W	1
B. A. C. 246	7, 8	0 47·9	70 9	1880 Mar. 15	·20	79·1	20·50	4	4	2	180	W	2
p Eridani	—	1 35·2	56 48	„ „ 8	·18	231·9	6·51	10	10	3	180	W	3
„	—	„	„	„ „ 9	·19	233·3	6·23	7	7	2	180	W	4
„	—	„	„	„ May 30	·41	233·4	6·55	6	2	2	—	E	5
„	—	„	„	„ Oct. 7	·77	235·0	6·57	6	6	2	320	E	6
„	—	„	„	„ „ 11	·78	234·5	6·24	10	10	2	320	E	7
„	—	1 35·3	56 48	1882 Mar. 6	·18	233·0	7·01	5	5	2	180	W	8
„	6, 6	1 35·4	56 47	1885 Mar. 11	·19	230·5	7·10	10	10	—	180	W	9
θ Eridani	$4\frac{1}{2}$, $5\frac{1}{2}$	2 53·8	40 47	1882 Mar. 11	·19	85·0	8·44	5	5	3	180	W	10
12 Eridani	4, 7	3 7·1	29 27	„ „ 13	·20	318·0	—	10	—	2	180	W	11
Lacaille 1181	$6\frac{1}{2}$, 7	3 35·5	40 44	„ „ 13	·20	227·5	7·96	3	3	2	180	W	12
f Eridani	5, $5\frac{1}{4}$	3 44·2	37 59	„ „ 11	·19	203·0	7·25	5	5	3	180	W	13
θ Reticuli	$6\frac{1}{2}$, 8	4 16·4	63 33	„ „ 17	·21	5·4	—	7	—	1	180	W	14
Lacaille 1475	$6\frac{1}{2}$, $6\frac{1}{2}$	4 21·9	57 20	„ „ 13	·20	236·2	6·36	5	5	2	180	W	15
ι Pictoris	5, 6	4 48·3	53 40	„ „ 11	19	58·2	12·18	5	5	3	180	W	16
Lacaille 2145	$8\frac{1}{4}$, $8\frac{1}{2}$	6 1·7	48 27	1881 Mar. 19	·21	12·7	2·50	9	5	2	180	W	17
„	$8\frac{1}{4}$, $8\frac{1}{2}$	„	„	„ „ 21	·22	10·1	2·42	12	4	2	180	W	18
„	—	6 1·7	48 27	1882 Feb. 21	·14	24·4	—	5	—	1	180	W	19
„	—	„	„	„ „ 25	·15	24·6	—	10	—	1	180	W	20
„	—	„	„	„ Mar. 6	·18	23·3	—	12	—	2	180	W	21

Name of Star.	Observed Magnitudes.	Approx. place at beginning of Year of Observation. R.A. h m	Declin. South. ° ′	Year, Month, and Day of Observation.	Fraction of Year.	Position Angle. °	Distance. ″	No. of Measures. Position.	No. of Measures. Distance.	Weight of Result.	Magnifying Power.	Obs. E. or W. of Merid.	Ref. No. to Remarks.
Lacaille 2145	—	6 1·7	48 27	1882 Mar. 22	·22	19·7	—	10	—	1	180	W	22
,,	—	,,	,,	,, Nov. 24	·90	16·2	—	10	—	—	320	E	23
,,	7, 8	6 1·8	48 27	1885 Mar. 6	·18	20·4	—	10	—	—	180	W	24
,,	7, 7½	,,	,,	,, ,, 10	·19	19·2	—	15	—	2	180	W	25
Brisbane 1201	6½, 8	6 11·9	65 30	,, ,, 10	·19	116·8	20·52	7	7	2	180	W	26
V Puppis	6, 8	6 35·5	48 7	1881 Mar. 16	·20	318·2	12·69	9	10	3	180	W	27
Lacaille 2640	7½, 8	7 1·4	59 0	,, ,, 24	·23	82·4	—	8	—	1	320	W	28
,,	7½, 8	,,	,,	,, ,, 24	·23	79·6	—	8	—	1	180	W	29
,,	—	7 1·4	59 0	1882 Mar. 22	·22	77·8	—	10	—	1	180	W	30
Lacaille 2685	7½, 7½	7 8·1	55 24	1885 Mar. 11	·19	45·8	7·10	5	5	—	180	W	31
γ Argûs, A. B.	2, 5	8 5·9	46 59	1881 Mar. 21	·22	219·0	42·46	5	5	3	180	W	32
,,	2, 5	,,	,,	,, ,, 22	·22	219·7	—	10	—	3	180	E	33
,,	2, 5	,,	,,	,, ,, 24	·23	219·5	—	3	—	3	180	W	34
γ Argûs, A. C.	2, 7½	8 5·9	46 59	,, ,, 22	·22	151·2	—	10	—	3	180	E	35
,,	2, 7½	,,	,,	,, ,, 24	·23	151·5	64·42	4	3	3	180	W	36
Lacaille 4031	8¼, 8¼	9 43·7	34 28	,, ,, 17	·21	126·5	5·61	5	5	1	130	E	37
o Argûs	3, 8	9 44·1	64 31	1880 Apr. 16	·29	125·4	4·94	5	5	2	—	W	38
Lacaille 4268	—	10 15·5	64 6	1885 Mar. 14	·20	317·3	2·48	10	5	3	180	E	39
s Velorum	6 6	10 26·9	44 27	1881 Mar. 17	·21	217·7	13·68	5	5	3	180	E	40
,,	6, 6½	10 26·9	44 28	1882 Mar. 10	·19	218·9	12·68	5	5	2	180	E	41
,	6, 6½	10 27·0	44 29	1885 Mar. 7	·18	218·9	12·92	10	10	3	180	E	42

Name of Star.	Observed Magnitudes.	Approx. place at beginning of Year of Observation. R.A. h m	Declin. South. ° ′	Year, Month, and Day of Observation.	Fraction of Year.	Position Angle. °	Distance. ″	No. of Measures. Position.	Distance.	Weight of Result.	Magnifying Power.	Obs. E. or W. of Merid.	Ref. No. to Remarks.
Lacaille 4350	6½, 7	10 28·6	54 47	1882 Mar. 10	·19	29·4	25·63	3	3	2	180	E	43
h 4392	8, 8	10 53	70 44	1885 Mar. 19	·21	160·0	25·01	5	5	2	130	E	44
α Crucis	—	12 19·9	62 26	1880 Feb. 28	·16	120·5	5·11	3	3	1	180	W	45
,,	—	,,	,,	,, Mar. 9	·19	120·9	4·75	3	3	2	—	W	46
γ Centauri	—	12 35·0	48 19	1882 Mar. 22	·22	2·1	—	10	—	3	320	E	47
γ Virginis	—	12 35·6	0 47	1880 May 20	·38	157·2	5·83	6	6	2	320	W	48
,,	—	,,	,,	,, ,, 28	·41	157·1	5·65	7	6	2	—	W	49
α Centauri	—	14 31·5	60 20	,, Feb. 28	·16	185·1	5·10	3	2	1	180	W	50
,,	—	,,	,,	,, Mar. 8	·18	182·6	5·08	6	5	1	—	W	51
,,	—	,,	,,	,, ,, 8	·18	186·7	4·97	8	8	2	—	W	52
,,	—	,,	,,	,, ,, 8	·18	181·2	5·72	3	3	2	180	E	53
,,	—	,,	,,	,, May 7	·35	186·4	5·31	10	10	3	320	E	54
,,	—	,,	,,	,, ,, 28	·41	184·0	5·94	3	3	2	—	E	55
,,	—	,,	,,	,, ,, 29	·41	185·2	5·43	10	10	2	—	E	56
,,	—	,,	,,	,, Oct. 8	·77	188·7	6·13	8	8	3	320	W	57
,,	—	14 31·5	60 21	1881 Aug. 24	·64	191·8	7·89	8	8	2	180	W	58
,,	—	,,	,,	,, ,, 30	·66	194 5	8·00	8	8	2	—	W	59
,,	2, 3	14 31·6	60 21	1882 Mar. 22	·22	194·6	8·70	7	7	3	320	E	60
,,	—	14 31·7	60 21	1884 July 9	·52	199·5	12·92	10	10	2	180	E	61
,,	—	,,	,,	,, ,, 9	·52	200·9	13·01	10	10	2	180	W	62
,,	—	,,	,,	,, ,, 12	·53	198·9	12·68	6	6	2	180	E	63

Name of Star.	Observed Magnitudes.	Approx. place at beginning of Year of Observation. R.A. h m	Declin. South. ° ′	Year, Month, and Day of Observation.	Fraction of Year.	Position Angle. °	Distance. ″	No. of Measures. Position.	Distance.	Weight of Result.	Magnifying Power.	Obs. E. or W. of Merid.	Ref. No. to Remarks.
α Centauri	—	14 31·7	60 21	1884 July 12	·53	199·4	13·07	6	6	1	180	W	64
,,	—	,,	,,	,, ,, 18	·55	198·9	12·98	8	8	3	180	E	65
,,	—	,,	,,	,, ,, 18	·55	201·2	12·92	8	8	2	180	W	66
,,	—	14 31·8	60 22	1885 July 11	·52	198·6	13·47	4	5	3	—	E	67
,,	—	,,	,,	,, ,, 11	·52	201·7	14·03	4	5	1	—	W	68
,,	—	,,	,,	,, ,, 27	·57	199·8	14·40	7	7	3	—	E	69
,,	—	,,	,,	,, ,, 27	·57	202·0	14·17	7	7	2	—	W	70
,,	—	,,	,,	,, ,, 31	·58	200·8	14·08	10	10	3	—	E	71
,,	—	,,	,,	,, ,, 31	·58	201·2	14·17	10	10	2	—	W	72
,,	—	,,	,,	,, Aug. 3	·59	201·1	—	10	—	3	—	E	73
,,	—	,,	,,	,, ,, 3	·59	201·2	—	10	—	2	—	W	74
α Circini	—	14 33·2	64 28	,, ,, 8	·60	239·2	15·95	5	5	1	—	W	75
μ Lupi	5, 5½	15 10·3	47 26	1882 Mar. 10	·19	160·5	—	8	—	—	320	E	76
Lacaille 6477	7, 7	15 37·4	65 5	1885 Aug. 8	·60	152·2	2·32	5	5	2	—	W	77
ξ Lupi	6, 6½	15 49·3	33 37	1881 Aug. 30	·66	49·9	10·55	5	5	3	—	W	78
η Lupi	4, 7½	15 52·2	38 3	,, Sept. 8	·69	20·3	14·93	6	6	3	180	W	79
,,	5, 9	15 52·5	38 4	1885 Aug. 1	·58	19·7	15·21	5	5	2	180	W	80
36 Ophiuchi	6, 6	17 8·0	26 25	1881 Sept. 8	·69	200·6	4·77	5	5	2	320	W	81
Lacaille 7267	7½, 8	17 18·4	45 44	1885 Aug. 1	·58	264·5	2·85	10	5	3	180	E	82
κ Coronæ Aust.	5½, 7	18 25·2	38 49	1881 Sept. 10	·69	0·7	21·95	3	3	1	320	W	83
Lacaille 7924	8, 8	18 53·2	63 57	1885 Aug. 5	·59	110·7	2·14	10	5	1	—	E	84

Name of Star.	Observed Magnitudes.	Approx. place at beginning of Year of Observation. R.A. h m	Declin. South. ° ′	Year, Month, and Day of Observation.	Fraction of Year.	Position Angle. °	Distance. ″	No. of Measures. Position.	No. of Measures. Distance.	Weight of Result.	Mag. nifying Power.	Obs. E. or W. of Merid.	Ref. No. to Remarks.
h 5092	8, 8½	19 5	47 33	1885 July 30	·58	351·8	17·58	5	5	3	180	E	85
Lacaille 8443	7½, 8	20 28·0	75 45	„ „ 31	·58	15·9	17·46	7	7	3	—	E	86
Lacaille 8550	7, 7	20 42·0	62 51	„ Aug. 4	·59	96·9	3·12	8	8	3	180	E	87
Lacaille 8687	8½, 8½	21 2·0	55 2	„ July 27	·57	122·5	3·65	10	5	3	90	E	88
θ Indi	6, 8	21 11·7	53 56	„ „ 30	·58	288·2	4·40	5	5	3	180	E	89

Remarks.

1. It was difficult to decide which was the brighter component, but that in the north preceding quadrant was probably so.

3, 4, 5, 6, 7. The same difficulty presented itself, but I think the north following was the brighter.

8. Although the components were very nearly equal, there was no doubt about the north following star being the brighter.

9. It was impossible to determine which was the brighter. 11. Estimated distance = 1″·5. 14. Companion seen with difficulty.

15. It was difficult to decide which was the brighter. 17. One or both of these stars probably variable 24. Estimated distance = 1″

25. On setting the position circle to 12° the deviation of the line joining the components from parallelism to the position threads was very sensible. 28, 29. Estimated distance = 2″·0. 30. Estimated distance = 2″·5.

31. Impossible to decide which was the brighter. 37. The components were equal. 40. The following component the brighter.

41, 42. Both the Cape and Sydney Catalogues make the components equal, and place the angle in the first quadrant. On March 10, 1882, and March 7, 1885, the north following star was decidedly the brighter. 44. The north preceding star probably the brighter.

47. Components exactly equal: estimated distance = 2″·0. 49. The north star apparently the brighter.

67, 68. The distances are deduced from the observed position angle and differences of declination.

76. Estimated distance = 2″·0. 80. The Sydney Catalogue gives the distances as 7·06 in 1879.

81. Difficult to decide which was the brighter, but probably the northern star. The magnitudes assigned to the components in the *Handbook of Double Stars* by Crossley, Gledhill, and Wilson are 4½ and 6½. 84. Components equal, hazy, and ill-defined.

Windsor, N.S. Wales:
1885, *Oct.* 9.

Observations of Magnitude of Nova Andromedæ made at the Radcliffe Observatory, Oxford.

(*Communicated by E. J. Stone, M.A., F.R.S.*)

The following estimations of magnitude of *Nova Andromedæ* were made with the 10-foot Equatorial of 7-inch aperture, except on September 19 and 21, when the Heliometer, of which the aperture is 7·5, was used.

Day and Hour.		Observed Magnitude.	Observer.	Power used.
	h			
Sept. 9	10	8·0	R.	45 (*a*)
17	10	8·5	W.	45 (*b*)
18	9	8·5	W.	45
19	10½	8·5	W.	45
21	10½	9·2	W.	45
22	8	9·5	W.	45
	9½	9·3	R.	45
24	10	9·6	W.	45 (*c*)
25	9¾	8·7 (*d*)	R.	45
	9¾	9·6	W.	45
26	8½	10·0	F.B.	125
29	9½	10·7	F.B.	125
	9½	11·0	R.	125
	9¼	10·3	W.	45
30	9	10·7	F.B.	125
Oct. 1	8	10·9	W.	125
3	9½	10·8	F.B.	125 and 160
5	6½	10·7	R.	160
	8	10·7	F.B.	125
	9	10·6	W.	125 (*e*)
7	8	11·3	F.B.	125
12	10	11·2	F.B.	125
16	9	11·2	R.	160
	9½	11·1	F.B.	160
27	7½	11·7	F.B.	125
	7½	12·0	W.	125
Nov. 5	9½	12·6	F.B.	125
28	7½	13·5	F.B.	125 and 160
Dec. 1	8	—	F.B.	125 (*f*)
4	8	13·6	F.B.	160 and 295 (*g*)
10	8	14·0	F.B.	295 (*h*)

The following observations of magnitude were made with the Transit circle:—

Day and Hour.		Observed Magnitude.	Observer.	Power used.
	h			
Sept. 21	12½	9·7	R.	80
25	12½	9·5	R.	115
26	12¼	9·7	F.B.	143
30	12	10·2	F.B.	143
Oct. 5	11¾	10·4	R.	143

Remarks.

(*a*) Reddish; very slightly fainter than Arg. Z + 40°, No. 165 (mag. 7·9) and No. 167 (mag. 7·7).

(*b*) Yellowish-red. Suspicion of a faint companion. With power 125 *Nova* duller, like a comet nucleus.

(*c*) With power 125 *Nova* dull and flat, stars bright and sharp.

(*d*) This observation was hurriedly made, the observer being on duty with the Transit circle. Transit circle mag. by Observer R. gives 9·5.

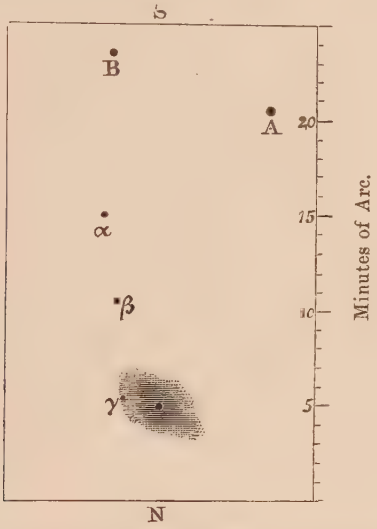
(*e*) Seems somewhat brighter than on Oct. 1.

(*f*) *Nova* and condensation still distinctly visible; mag. not observed.

(*g*) Condensation more distinct than *Nova*, which was extremely faint.

(*h*) *Nova* only just discernible; nucleus or condensation of nebula and γ distinctly visible.

The following is a chart of approximate positions of the stars used for comparison of magnitudes:—



The adopted observed magnitudes of the above comparison stars are as follows:—

A = 9·0	β = 11·4
B = 9·0	γ = 13·0
α = 11·0	

The approximate observed places for 1885, January 1, obtained with the 10-foot Equatorial, are—

	Approx. R.A. h m s	Approx. N.P.D. °	
α ...	0 36 11	49 31·4	
B ...	0 36 13	49 40·3	Arg. $z+40°$, No. 145
β ...	0 36 17	49 27·1	
γ ...	0 36 18	49 22·1	
Nova ...	0 36 27	49 21·7	
A ...	0 36 58	49 37·2	Arg. $z+40°$, No. 149

Observers.—W.=Mr. W. Wickham; R.=Mr. W. H. Robinson; F.B.=Mr. F. A. Bellamy.

Radcliffe Observatory, Oxford:
1885, *Dec.* 11.

On a Suspected New Variable Star in Corona Borealis.

By J. E. Gore.

With reference to Mr. Chambers' paper in the Supplementary Number of the *Monthly Notices* (No. 9, vol. xlv.), I beg to point out that the red star *Birmingham* 361 (=Schj. 182) is identical with the known variable star *V Coronæ* (No. 109 of my *Catalogue of Known Variable Stars*), its variability having been discovered by Dunér in 1878, and confirmed by the observations of Chandler, Hartwig, Safarik, Schmidt, and Wilsing. The variation is from $7^{m}5$ to 12^{m}, and the period about $359\frac{1}{2}$ days. The following maxima have been observed:—

1878, Oct. 5	Dunér.
1879, Oct. 12	Schmidt.
1881, Oct. 3	Schmidt.
1882, Sept. 15·6	Schmidt.
1883, Sept. 24 ($7^{m}7$) ...	Chandler.
1883, Sept. 5	Schmidt.

The red star observed by Mr. Chambers on August 13, 1885, was most probably *V Coronæ*, as a maximum was due this year early in September. I may add that, according to Chandler, the period given above agrees well with the invisibility of the star to *Birmingham* in 1873 and 1874, and the observations by Ball in 1876, and by Dreyer in 1879 and 1880.

Ballysodare, Co. Sligo:
1885, *Nov.* 19.

Occultation of Uranus, 1885, *December* 1.

By the Rev. S. J. Johnson.

Disappearance at the Moon's bright limb took place at a point in a line with *Marius* north of *Grimaldi*, at $4^{h}\ 56^{m}\ 16^{s}$ morning. Sky perfectly clear. Reappearance $6^{h}\ 6^{m}\ 42^{s}$, also in a clear sky. Time by sextant. With power of 50 on $3\frac{1}{4}$ inches, planet rather minute at immersion; at emersion bright and distinct, somewhat between a planetary disc and a star. Some interest is attached to this phenomenon from the fact of the planet having disappeared six minutes before the predicted time in March 1871 (calculated from former tables), several observers being on that occasion disappointed of the observation.

Melplash Vicarage, Bridport:
1885, *Dec.* 8.

Observations of Comets—Brooks, Fabry, and Barnard—made at Dun Echt Observatory with the Filar Micrometer of the 15-inch Refractor.

(*Communicated by the Earl of Crawford and Balcarres.*)

Object.	Date. 1885	Dun Echt Mean Time. h m s	Comet—Star. Δα m s	Δδ ′ ″	α Comet. h m s	δ Comet. ° ′ ″	Observer.	Remarks.
Brooks ...	Oct. 5	9 3 41	+0 14·98	−0 4·1	17 29 38·11	+41 35 41·4	L. B.	Very faint, 3′ diam.
Fabry ...	Dec. 7	8 20 59	+2 22·57	−3 31·8	0 25 10·02	+20 52 45·4	R. C.	Diam. 40″, brighter towards the preceding side.
Barnard ...	7	12 21 45	+3 42·26	−1 54·9	4 12 29·07	+ 5 3 52·9	R. C.	Diam. 1′, considerably brighter in the middle.

Adopted Mean Places of Comparison Stars for 1885·0.

1885	α h m s	Redn. s	δ ° ′ ″	Redn. ″	Authorities.
Oct. 5	17 29 22·46	+0·67	+41 35 21·2	+24·3	Connected with B. W_2. 812.
	17 27 38·27		+41 35 23·8		B. W_2. 812.
Dec. 7	0 22 44·03	+3·42	+20 55 52·1	+25·1	Bonn Observations, Vol. VI. +20°, 47.
7 (*bis*)	4 8 42·70	+4·11	+ 5 5 45·8	+ 2·0	B. W. 4^h 123.

The observers' initials are those of Ralph Copeland and L. Becker.

Observations of the Biela Comet Meteors made at the Royal Observatory, Greenwich.

(*Communicated by the Astronomer Royal.*)

Greenwich Mean Solar Time Astronomical.		Number of Meteors seen by F.	Number of Meteors seen by L.	Number per minute seen by F.	Number per minute seen by L.	State of the sky.
1885. Nov. 27	h $5\frac{1}{2}$	—	—	—	—	Cloudy; no meteors seen.
	6	—	—	—	—	Sky nearly cloudless; meteors seen in considerable numbers, and continued to be seen until the commencement of counting at $6^h\ 18^m$
	h m h m					
	6 18 to 6 37	626	—	32·9	—	
	6 37 6 47	—	200	—	20·0	
	6 37 6 49	449	—	37·4	—	
	6 49 6 58	—	100	—	11·1	
	6 51 6 59	109	—	13·6	—	
	6 58 7 4	10	—	1·7	—	
	7 5 7 15	—	13	—	1·3	Clouds appeared shortly before 7^h; sky nearly covered at 7^h.
	7 30	—	—	—	—	Several bright meteors seen through thin clouds.

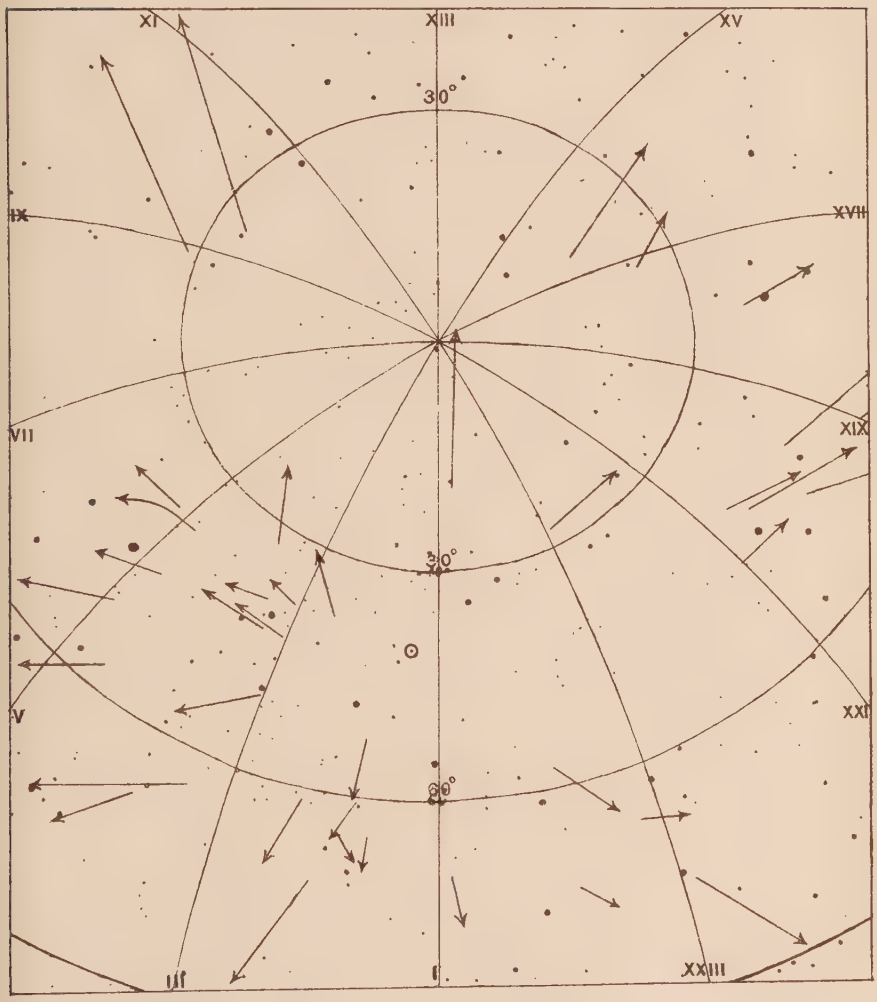
Greenwich Mean Solar Time Astronomical. 1885.			Number of Meteors seen by		Number per minute seen by		State of the sky.
	h m	h m	F.	L.	F.	L.	
Nov. 27	7 52 to	7 55	42	27	14·0	9·0	Partially cloudy; clouds variable in amount.
	7 55	8 2	91	101	13·0	14·4	
	8 2	8 7	66	37	13·2	7·4	
	8 12		—	—	—	—	Sky nearly covered; meteors still seen through small breaks and thin clouds.
	8 12	8 22	—	—	—	—	Meteors frequently seen through small breaks in the clouds.
	8 27	8 32		—	12·4	—	Seen chiefly in east and east-south-east.
	8 32	8 37	38	—	7·6	—	Seen chiefly in east and east-south-east; light clouds prevalent.
	8 37	8 52	—	—	—	—	Sky generally covered.
	8 57	9 2	29	—	5·8	—	Partially cloudy.
	9 2	9 7	19	—	3·8	—	,, ,,
	9 7	9 12	30	—	6·0	—	,, ,,
	9 12	9 17	32	43	6·4	8·6	Less cloud now.
	9 17	9 22	53	42	10·6	8·4	Few light clouds.
	9 22	9 27	55	54	11·0	10·8	,, ,,
	9 27	9 32	36	43	7·2	8·6	Cloudy in north and north-west.

Greenwich Mean Solar Time Astronomical.			Number of Meteors seen by		Number per m seen by		State of the sky.
1885.	h m	h m	F.	L.	F.	L.	
Nov. 27	9 32	to 9 37	40	47	8·0	9·4	Cloudy in north and north-west; nearly clear in south.
	9 37	9 42	28	—	5·6	—	,, ,, ,, ,,
	9 42	9 47	13	28	2·6	5·6	Partially cloudy.
	9 52	9 57	4	24	0·8	4·8	Cloudy in north.
	9 57	10 2	3	5	0·6	1·0	Cloudy.
	10 2	10 7	1	1	0·2	0·2	Nearly covered.
	10 7	10 12	1	0	0·2	0·0	Cloudy in south; clouds broken in north.
	10 12	10 17	8	3	1·6	0·6	Cloudy in north and south.
	10 17	10 22	11	26	2·2	5·2	Cloudy in north; clearer in south.
	10 22	10 27	13	16	2·6	3·2	Light cloud in north.
	10 27	10 32	10	12	2·0	2·4	Cloudy in north and east.
	10 32	10 37	6	7	1·2	1·4	Cloudy.
	10 37	10 42	1	1	0·2	0·2	,,
	10 42	10 47	9	8	1·8	1·6	,,
	47	10 52	11	6	2·2	1·2	,,
	10 52	10 57	5	1	1·0	0·2	,,
	10 57	11 2	3	4	0·6	0·8	,,

ROYAL OBSERVATORY, GREENWICH.

CHART OF METEOR TRACKS,

Observed by Mr. Nash on the night of 1885, November 27.



Spottiswoode & Co. Lith. London

Radiant point shown thus. ⊙

In the above counting the observers were placed back to back, Mr. Finch (F.) facing the northern portion of the sky, and Mr. Letchford (L.) the southern portion. The observers were careful that any meteors seen by both of them should be included in the count of one observer only.

Mr. Nash also reports that on the night of November 26 the sky was cloudy and the weather unfavourable for observation. On November 27 it remained cloudy till nearly 6^h; the sky then cleared somewhat suddenly, and meteors were found to be appearing in such numbers that steps were immediately taken by Messrs. Finch and Letchford to count them. Mr. Nash himself found that in and near the constellations *Cygnus* and *Lyra* alone, at $6^h\ 30^m$, and again at $6^h\ 50^m$, meteors were falling at the rate of thirty per minute; and deeming it impossible to make a complete and reliable description of the meteors then appearing, on account of their numbers, and fearing the probability of cloud intervening, he devoted his attention chiefly to the determination of the principal radiant point, which he found from numerous meteor paths of suitable brevity to be situated at R.A. 20° and Dec. N. 49°, referring to the period between 6^h and 7^h. After 7^h the sky was only clear at intervals, and forty tracks were then plotted on a prepared chart, principally from observations made between 8^h and $9^h\ 30^m$, confirming the preceding determination of the radiant. During the principal portion of the display (6^h to 7^h) the meteors were mainly white in colour and trained, unusually short in path and slow in motion, and the number of small meteors was remarkably large. After 9^h the numbers dropped off very perceptibly, and by 11^h, when the sky clouded up completely, they had fallen to two or three per minute. On November 28, with a clear sky during the greater part of the evening, a watch was maintained by one observer for nearly two hours, and ten meteors only were seen, of which four were apparently referable to the Biela Comet radiant.

The radiant point being situated near the centre of projection of the map, the meteor paths as plotted remain practically straight lines. In one case the path was actually observed to be curved.

Royal Observatory, Greenwich:
1885, *Dec.* 17.

Observations of the Meteor Shower of November 27, 1885, *made at the Glasgow Observatory.* By Prof. R. Grant, LL.D., F.R.S.

The meteors were first seen at the Glasgow Observatory a little before six o'clock in the evening. It was not long before it became evident that the number of meteors visible in a given time was gradually increasing. It was equally manifest that the position in the heavens from which the meteors appeared to diverge was situated in *Andromeda*, very near the stars γ and χ of that constellation. In general the meteors resembled in brightness stars of the 2nd and 3rd magnitudes, but a considerable number of them were equal to stars of the 1st magnitude, and every now and then there would burst forth a beautiful meteor rivalling in splendour the planet *Jupiter*. The colour of the meteors was generally white. In the case of the larger meteors, however, the light at the instant of breaking up of the meteor was characterised by a ruddy or orange hue. All the meteors except those in the immediate vicinity of the radiant point were in every instance accompanied by a luminous train, which, however, remained visible only two or three seconds. The abundance of meteoric apparitions seemed to have attained its maximum about $6^h\ 40^m$ G.M.T. Henceforth they gradually declined in numbers, and a haze coming on about 8 P.M. practically put an end to the wondrous display. Occasionally, however, a meteor might be seen traversing the atmosphere until about 10 P.M., when every trace of the phenomenon disappeared.

From a comparison of the apparent positions of three stationary meteors relatively to γ and χ *Andromedæ* I estimated the position of the radiant point to be very nearly R.A. 24°, Dec. N. 45° 30′. At the commencement of the shower Mr. H. Urquhart, one of the Observatory assistants, was detailed to count the meteors visible. The following are the results of his enumeration :—

G.M.T. h m	Number of Meteors visible per minute.	G.M.T. h m	Number of Meteors visible per minute.
6 3	54	7 00	60
6 8	56	7 5	74
6 13	58	7 10	44
6 18	67	7 15	32
6 23	50	7 20	33
6 30	64	7 25	23
6 35	80	7 30	23
6 40	80	7 35	38
6 45	50	7 40	24
6 50	48	7 45	23
6 55	70	7 50	23

Mr. Tannien, another assistant, made a partial enumeration of the meteors visible with the following results :—

G.M.T.	Number of Meteors visible per minute.	G.M.T.	Number of Meteors visible per minute.
h m		h m	
6 24	60	7 1	74
6 36	100	8 9	9

Mr. Urquhart continued counting without interruption the number of meteors visible from $5^h\ 58^m$ till $7^h\ 50^m$, embracing an interval of one hour and fifty-two minutes, and obtained 5,806 as the aggregate number of meteors visible. From what I have seen of such apparitions I am inclined to think that the number of meteors actually visible from the Glasgow Observatory during the interval to which I refer was at least four times as great as this number.

It has been my good fortune to have seen from this Observatory the great meteor shower of November 13, 1866, and also the meteor shower of November 27, 1872, in both instances under exceptionally favourable circumstances, and at the time of the recent shower I was naturally led to institute a comparison between the brilliant apparition then visible and the two preceding displays. The shower of the *Leonides* appeared to me to be beyond comparison the grandest of the three apparitions both in respect to the abundance and the magnitude of the meteors. On the other hand the recent apparition of the *Andromedes* offered a most striking resemblance in every respect to its brilliant predecessor of 1872.

The Biela Meteor Shower of November 27, 1885. By Prof. C. Pritchard, D.D., F.R.S.

Preparations were duly made at the University Observatory for recording what might occur in relation to the expected *Andromeda* meteors. Specially it was proposed to watch the neighbourhood of the radiant through a 4-inch telescope with a low power eye-piece, giving a field of about 50′ diameter.

The sky was generally fitful, never being wholly without cloud and frequently overcast. Slight rain fell at 9 P.M., and at intervals between that hour and 2 A.M.

Very many meteors were reported as flying about the sky by pedestrians in the city, as soon as it became sufficiently dark. The first count at the Observatory was made by the two assistants from 6 to 6.10 P.M., the one looking on the eastern sky and the other on the western. During this period sixty were counted,

but with the certainty that many had escaped notice. Their character was in general fleecy and small. Five of them were observed to pass over the square of *Pegasus* parallel to the diagonal joining *α Andromeda* to *α Pegasi*. The sky then became too cloudy to continue counting.

Between $6^h\ 34^m$ and $6^h\ 39^m$ G.M.T., when the sky had partially cleared, 102 were counted towards the eastern side and 149 on the western. The sky was then scrutinised through the 4-inch telescope in the neighbourhood of the presumed radiant. Not a single short meteor or evanescent star-like outburst was seen, though the sky was then at its clearest. Comparing the result with my recollection of the November meteors in 1866, the total absence of the expected phenomenon is worthy of notice.

Between $7^h\ 14^m$ and $7^h\ 19^m$ there were counted 104 on the eastern sky and 201 on the western. No meteors were seen apparently brighter than *Sirius*. Six bright meteors, of approximately the brightness of stars of the 1st magnitude, observed by Mr. Plummer between $6^h\ 53^m$ and $8^h\ 15^m$, gave the radiant near *ω Andromedæ* (R.A. 21°, N.P.D. 45°), which agreed with the general impression derived from the other meteors. Mr. Jenkins, from his observations, regarded the radiant as a little more easterly, viz. about R.A. 23°, and N.P.D. 46°. No further available observations were possible during the remainder of the night, owing to the general prevalence of clouds and rain.

University Observatory, Oxford:
1885, *Dec.* 10.

On the Meteoric Shower of November 27, 1885.

By Ralph Copeland, Ph.D.

On the night of November 27, 1878, Lord Lindsay (now Lord Crawford) and the writer watched at Dun Echt for the greater part of eight hours for any possible return of the Biela meteors of 1872. As far as the meteors in question were concerned, the immediate result was almost altogether negative, for scarcely a single shooting-star was seen which could be referred to a radiant in *Andromeda*. The conclusion, however, was obvious, that the meteors were not, by any means, distributed round the whole orbit of the lost comet. But by taking the comet's period at 6 years and 202 days, as given in the appendix to Herschel's *Outlines of Astronomy*, 11th edition, it became evident that in 1885, November 27, would fall only 40 days short of two periods elapsed since the grand display in 1872, and would afford the best chance that could occur during the remainder of

this century. This conclusion was communicated to the Royal Astronomical Society, along with a *résumé* of the above-mentioned observations.*

From the 22nd until the 26th inst. the nights at Dun Echt were unusually cloudy, so that no telescopic or other examination of the neighbourhood of the meteoric radiant was at all possible. At nightfall on the 27th a dense vault of clouds covered the whole heavens, excepting only an occasional clear streak on the horizon. It was at 5.45 G.M.T. that numerous bright meteors were first seen descending across this streak. But the clouds soon lifted and thinned rapidly, so that from $6^h\ 13^m$ to $6^h\ 21^m$ I was able to count 109 meteors which could be referred to a common source in the direction of *Andromeda*. They were all of one clearly-marked type, moving somewhat slowly, with well-defined heads, and of all degrees of brightness, from the 2nd magnitude down to the faintest streaks that the eye could distinguish. Occasionally one of fully the 1st magnitude would leave a train that lasted for four or five seconds. The meteors came, now singly, now in pairs, and not infrequently in bursts of five or six at a time.

By holding a direct-vision prism with the refracting angle in the direction of the paths of the meteors, and watching a part of the sky in which they were most numerous, it was not difficult to catch an occasional sight of their spectra. Of seven spectra seen in this way, all were of the same kind, consisting of a somewhat faint continuous spectrum, with one relatively very bright line. The position of this line was not determined, but it is probably not far from F. Indeed, the whole spectrum was rather like that of a bright planetary nebula superposed on a faint continuous spectrum.

Nineteen well-situated paths, noted between $7^h\ 17^m$ and $8^h\ 3^m$, gave a very definite radiant point in R.A. $25°{\cdot}9$ and N. Decl. $46°{\cdot}4$. An examination of this point and its surroundings with a very low power on a 6-inch telescope revealed nothing, while some little time was lost in the identification of the remarkable double nebula.—*Gen. Cat.*, Nos. 385–6.

In the mean time 700 meteors were counted towards the east, from $7^h\ 10^m$ to $7^h\ 30^m$ G.M.T.; while a member of my family numbered almost exactly 2,000 in the S.W. between $6^h\ 30^m$ and $7^h\ 30^m$, although in both cases the sky was often at least half clouded over. In half an hour, beginning at eight o'clock, favoured by a nearly clear sky, the last observer noted 864 meteors, again to the S.W. Shortly after nine o'clock, even while making every allowance for increasing cloud, it became most evident that the display was fast diminishing. About $10^h\ 40^m$ the canopy of cloud lifted a little towards the east for about ten minutes, but not a single meteor was seen to cross the

* See *Monthly Notices*, vol. xxxix., p. 520.

clear belt thus formed. Immediately afterwards heavy rain-clouds settled hopelessly down and concealed the sky for the rest of the night.

Dun Echt Observatory:
1885, *Nov.* 30.

The Great Shower of Andromedes, November 26, 27, 28, and 30, 1885. By W. F. Denning.

The nights of November 24 and 25 were overcast here.

On the evening of November 26 heavy rain fell before $8^h\ 30^m$, then the atmosphere cleared somewhat, and I counted 21 shooting stars in the ensuing 15 minutes. Of these, 19 were *Andromedes*. The sky then clouded again, but later on, through temporary breaks, I saw 42 additional meteors, including 41 *Andromedes*. I estimated that with a clear sky the hourly number visible for one observer was about 130. The radiant point was at $26°+44°$, but the observed tracks did not come precisely to a focus. It was necessary to adopt a radiant area of several degrees diameter in order to satisfy the directions. No observations were possible after $12^h\ 30^m$ on November 26; clouds and occasional storms interfered until daylight.

On November 27 the sky in the early evening was much involved in clouds and haze, but before the twilight had disappeared, and before any stars could be distinguished, I observed several fine *Andromedes* with their typical spark-trains and very slow motions. It was at once evident that since the preceding night the display had developed into one of great richness. As the sky grew darker the number of meteors rapidly increased, but the heavens continued to be so much involved in cloud that the real strength of the shower could not be adequately determined. I counted the meteors in intervals of five minutes as follow:—

		No. seen.	State of sky.
h m	h m		
5 10 to	5 15	33	Very cloudy and hazy. Only *Capella* and two or three other bright stars visible.
5 25	5 30	126	Sky very much overcast.
5 55	6 0	105	Sky more overcast, very few stars visible.
6 25	6 30	222	Clearer, but still hazy and the stars looking dim.

No regular observations could be obtained after $6^h\ 40^m$ owing to clouds and rain, which continued almost unabated

during the whole night. Before $9^h\ 15^m$, however, there occurred one or two transient breaks, and meteors were observed to be falling thickly, but only momentary glimpses were possible.

With a pefectly clear sky the number visible within the sphere commanded by one observer must have been equivalent to more than 5,000 per hour, judging from the richness of the phenomenon so imperfectly seen here between 6^h and $6^h\ 30^m$. The display was probably therefore quite equal to that of November 27, 1872. When clouds enforced the suspension of my observations, soon after $6^h\ 30^m$, the display was evidently intensifying; the meteors were beginning to fall in what may be described as intermittent volleys of 5, 7, or 10, and even more.

The radiant point was very inexact. In many cases I found that very accurately observed paths deviated several degrees from the mean. The area of radiation must have been fully 7° in diameter to accommodate the discordances in the flights. The centre was at $24° + 44°$, but I saw several very short paths from a point south of γ *Andromedæ*. I noted many of the meteors with the utmost care in order to assure myself of the diffuseness of radiation, and it was found impossible to get a sharply defined position. The contrary effect was indeed so obvious as to arrest the eye whenever simultaneous bursts of about six or seven meteors took place near the radiant. It was then seen that the collective flights were not symmetrical emanations from a central point. They rather appeared to be discharged in a loose, disjointed fashion from a comparatively large space on the N.W. region of γ *Andromedæ*, and just perhaps enveloping that star within its limits. With regard to this peculiarity the shower shows a departure from the rule I have found to obtain during the observation of minor streams. The tracks usually intersect almost at a point, and I believe that diffuse and uncertain radiation has a tendency to disappear altogether in cases where the observations are very exact. But every effort towards accuracy only exhibited the diffused radiation of the *Andromedes* in a more unmistakable manner, and proved it to be an inseparable feature of the shower's appearance.

Both on November 26 and 27 there was a tolerably large number of bright meteors. The very unfavourable weather here enabled me to make no comparative observations as to magnitude. It is certain that very few of the more minute *Andromedes* could be descried in a sky where stars below the 4th magnitude were hidden nearly the whole time. On November 26 I recorded several meteors as bright as *Jupiter*, and near to the maximum on November 27, some were seen brighter than *Venus*—many rivalled *Jupiter*. They invariably traversed short paths with very slow motions, and became extinct in evolved streams of yellowish sparks. Noting their visible aspects particularly, the conclusion seemed obvious that these meteors are formed of very

soft materials, which expand while incalescent, and are immediately crumbled and dissipated into exiguous dust. The resistance of the atmosphere upon some of the brightest of them appeared to be so effectual that they came almost to a standstill, and then disappeared with material and velocity alike spent.

On November 26 and 27 I noted about ten meteors of the class usually designated "sporadic." * Of these meteors, five were directed from a radiant point in *Cepheus* at 332°+58°. This has been observed before (though somewhat to the north of my position) by Dr. Konkoly on November 28, 1872, at 372°+63°, and by Mr. Sawyer on November 24, 1878, at 330°+63° (see *Monthly Notices*, vol. xl. p. 362, and *American Journal of Science and Arts*, vol. xvii, June 1879, Radiant No. 26). There is little doubt these are identical, the resemblance in position and epoch being very close.

Shower of *Andromedes*, 1885, Nov. 26 and 27. R.A. 25°, Dec. 44° N. (W. F. Denning.)

The following are a few of the paths registered here on November 26 and 27 :—

* The term hardly seems to me a commendable one, though undoubtedly useful to conceal our ignorance of the contemporary streams supplying meteors unconformable to any special display that may be under observation.

Date	Time	Mag.	Path Length. From		To		Notes.
	h m		°	°	°	°	
Nov. 26	8 42	4	48	+40	61	+36 ...11	V. slow, thick train.
26	8 51	1	26	67	26½	+76 ... 9	Very very slow, thick train.
26	9 47	1	94	51	112	46 ...13	Slow.
26	10 9	4	158	73½	177	60½...14½	V. slow, flash & train.
26	10 14	1	321	54	302	49 ...13	Slow, thick train.
26	10 33	1	46	13	52	2½...11	Very slow, train.
Nov. 27	5 19	1	15½	35	9	30½...17	,, ,,
27	5 22	♀	62	52	85	50½...14½	,, ,,
27	5 22	1	31	43	33½	42 ... 2	,, ,,
27	5 24	1	23	40½	21	39 ... 2	,, ,,
27	5 29	♀	20	25	18½	13 ...12	Slow, thick train.
27	5 31	1	3	42	347	38½...13	,, ,,
27	5 41	1	24	35½	22	31 ... 5	V. slow, thick train.
27	5 52	1	12	44	359½	42½... 9	,, ,,
27	6 10	1	5	46	354	45 ... 8	Slow, thick train.
27	6 12	1	7	20	1½	9 ...12	,,
27	6 17	1	351	64	326	66½...11	,,
27	6 17	1	15	60½	7½	66 ... 7	,,
27	6 34	1	10	54	356½	59 ... 9	,,
27	9 1	1	20¼	44½	18	44½... 1½	V. slow, thick train.

On November 28 the sky was magnificently clear until the moon rose at about $11^h\ 30^m$. Watching for about four hours in the aggregate—between $6^h\ 15^m$–$8^h\ 30^m$ and $9^h\ 30^m$–$11^h\ 30^m$—I saw sixty-five shooting stars. The shower of *Andromedes* still continued though entirely shorn of its imposing character. I observed some fifty-five meteors from the radiant near γ *Andromedæ*, but they were nearly all extremely minute, and many of them would have passed unobserved but for the exceptional clearness of the atmosphere. About thirty were of the 5th or 6th magnitude, and I just caught several which I rated as $6\frac{1}{2}$ magnitude. There was a marked absence of meteors from other showers during the evening, not more than about a dozen being recorded.

I expected to discover on the 28th some displacement capable of being defined in the position of the radiant, similar to that which affects the August *Perseids*, and which, to a greater extent, I observed in connection with the April *Lyrids* of the present year (*Nature*, No. 810, May 7, 1885, p. 5). In both these instances the change is in the direction of increasing R.A., but I find strong evidence amongst my results that the radiant of the *Andromedes* moves in the contrary direction. I append

several positions for comparison derived on the nights of November 26, 27, 28, and 30:—

	h m	h m	° °		h m	h m	° °
Nov. 26	8 38 to	8 57	26+44	Nov. 27	6 25 to	6 30	23+45
26	9 43	10 10	27+43	28	6 15	11 30	22+43½
26	11 50	11 59	26+43½	30	6 39	7 19	21+42½
27	5 0	6 0	24+43½				

Shower of *Andromedes*, 1885, Nov. 28. R.A. 22°, Dec. 43½° N.
(W. F. Denning.)

The position for the 28th was determined from thirty-five paths, and represents a much better-defined radiant than any of the others. The decidedly erratic character of the display on the 26th and 27th, as regards its focus of divergence, seemed to have disappeared, and the directions as I registered them on the 28th indicate a far more uniform point of intersection. My figures prove that this point is not stationary, but that it probably moves slowly to the westward.

On the 28th, at about $7^h\ 18^m$, I witnessed a curious outburst of very faint *Andromedes* in the region N. of *α* and *β Aurigæ*. Five meteors were noted here (three of which were very nearly simultaneous) in less than two minutes, and these were closely succeeded by three others, all nearly in the same positions. It cannot be regarded as any other than a singular coincidence that eight shooting stars, belonging to a shower yielding at the time certainly not more than twenty meteors per hour for one observer, should appear in the same identical region within a few minutes. From the number of meteors actually counted during the evening there were only fourteen *Andromedes* per hour, but this is unquestionably below the real figures, for many meteors are lost by an observer during the moments his attention is withdrawn from the heavens to register the paths of those seen, and this is a detail of the work which requires to be done deliberately and cautiously, for ten observed meteor tracks exactly reproduced on the chart, are worth more than a hundred wild and hurried observations. The latter are useless, as leading to doubts and complications, whereas every accurate meteor-path possesses a certain value.

At about midnight on the 28th storm clouds came up from the west, and at an early hour on the morning of the 29th rain began falling and continued without intermission for some thirty-four hours. Thus I had no opportunity of seeing anything on the night of the 29th, though constantly on the alert for an opening. The evening of the 30th, however, came in clear, and at $5^h\ 30^m$ I began a close watch of the region of *Andromeda*. During the first hour I observed six shooting stars belonging to minor showers. There was no sign from the radiant in *Andromeda*, and I concluded the display had become exhausted. But at $6^h\ 39^m$ I saw a faint, slow meteor close to *θ Cassiopeiæ*, and directed straight from the radiant. Ten minutes later another was recorded passing $\frac{1}{2}°$ N. of the great nebula M 31, and between $7^h\ 5^m$ and $7^h\ 19^m$ I saw four others, all very slow, and with the usual trains and short paths. The radiant was well defined at $21° + 42\frac{1}{2}°$. Observations were continued until $10^h\ 16^m$, when clouds overspread the sky. During my watch of $4\frac{1}{2}$ hours forty-one meteors were seen, of which ten certainly, and two others possibly, were *Andromedes*. It was the chief shower observed during the evening, though two others were equally well determined in respect of the points of radiation, viz. at—

$60° + 49°$	6 very swift meteors.
$41 + 39$	4 swift meteors.

I saw a bright 2nd magnitude meteor perfectly stationary at the former point at $8^h\ 32^m$. It is coincident with one of the special instances of stationary radiation which I referred to

in detail in my paper in the *Monthly Notices*, December 1884, pp. 103–4.

The following night, December 1, was again clear, and watching the sky during the four hours between $5^h\ 45^m$ and $9^h\ 45^m$ I observed twenty-five shooting stars. The shower of *Andromedes* appeared to have become extinct; not a single path could be positively assigned to that radiant, though at $7^h\ 57^m$ I saw a very small, slow meteor crossing λ *Tauri* from the right direction, but it was so extremely faint that I regard it as uncertain. We may therefore fairly assume that on the night of December 1 the display had definitely ceased, and that, in the interval elapsed since the preceding night, the Earth had fully emerged from the stream.

On the night of December 4 observations were resumed, and forty-eight shooting stars seen in another four-hours' watch. There was no sign of any radiation from γ *Andromedæ*, though I registered two bright slow meteors with thick trains from the point $9°+33°$, which represents quite a distinct shower. (See *Monthly Notices*, Dec. 1884, p. 110, Radiant No. 9.)

On December 7 thirty shooting-stars were recorded in $3\frac{1}{2}$ hours. At $6^h\ 46^m$ I saw a very short, quick meteor, probably near a radiant almost identical with the *Andromedes*. I had seen two additional meteors of the same character, one on November 28, the other on November 30; and the combined paths indicate the radiant at $19°+43\frac{1}{2}°$. There is possibly a feeble stream of hyperbolic meteors encountering the Earth at nearly the same date and position as the meteors of Biela's Comet. Two of the paths referable to the former shower were so short, and presumably so close to their radiant, that there can hardly be a doubt of its existence. These were as follows:—

		Mag.	Path.	
	h m			
Nov. 30	7 2	3	$11°+40°$ to $7°+38\frac{1}{2}°$	Swift and short.
Dec. 7	6 46	3	$20+41$ $21+39$	V. quick, nearly stationary.

In the aggregate I saw 115 meteors on the four nights, November 28 and 30, December 1 and 4, not conformable to the true *Andromedes*, and from these I have derived the following radiant points which it may be useful to specify, as some of them will doubtless be reobserved during future watches for the *Andromedes*. I have not included my results for December 7, as the date is rather distant from the epoch of the great display:—

Ref. No.	Radiant. α δ	No. of Shooting Stars seen.	Notes.
	$\alpha°$ $\delta°$		
1	$27+71$	4	Very slow, faint.
2	$41+39$	6	Swift, short.
3	$44+56$	8	Very slow, faint.
4	$60+49$	8	Very swift.

Ref. No.	Radiant. α	δ	No. of Shooting Stars seen.	Notes.
	°	°		
5	79	+24	5	Slow.
6	105	+34	8	Swift. Geminids.
7	110	+25	4	Rather slow.
8	143	+48½	6	Very swift. Streaks.
9	194	+43	8	„ „

The latter was the best shower. It is situated about 4° N. of *Cor Caroli*, and supplied several fine long meteors. That this stream should have rendered itself conspicuous, despite its unfavourable position (during nearly the whole of my observations), closely verging the northern horizon, proves it to be one of more than ordinary significance.

I have recently noticed great disparity in the relative velocities of neighbouring showers. In the preceding table of radiants it will be observed the meteors from No. 3 at 44°+56° (near η *Persei*) were very slow, while those from No. 4 at 60°+49° (near μ *Persei*) were "very swift." It is certain that if the meteors of these different streams become visible at nearly the same heights in the atmosphere, they must be moving with vastly different velocities. It will be important to further watch these swift meteors from radiants so distantly removed from the apex of the Earth's way.

The recorded duration of the recent display of *Andromedes* over at least five nights is remarkable when we remember the short-lived character of the shower on November 27, 1872. On the nights of the 25th and 26th November of that year I found meteors scarce, and the fact was confirmed by Mr. Jackson at Tooting. On the 28th I saw no lingering traces of the shower, and Mr. Greg at Buntingford, and several observers at Hawkhurst, in Kent, were similarly unsuccessful (*Nature*, No. 162, December 5, 1872, p. 104). If these observations are conclusive, the observed duration of the phenomenon of 1872 appears to have been limited to a single night. It could not have formed a display of any importance on either of the two nights preceding or following the maximum, though a distinct shower of these *Andromedes* appears to have been witnessed in America as early as November 24, 1872. They were watched by Mr. T. Hadley and Professors Twining and Newton at Newhaven between $7^h\ 30^m$ and 12^h, when their numbers were recorded as forty per hour for one observer, and the radiant point, as estimated by Professor Newton, was 2° or 3° N. of γ *Andromedæ* (*B. A. Report* for 1873, p. 387). This shower had, however, on the 25th declined to one-third its richness, as determined on the 24th, so that the display may probably have been due (especially when we regard the negative results obtained in England on the nights immediately prior to the 27th) to a closely outlying system which could hardly have been connected with the main

stream, from the utter absence of intermediate meteors on November 26. I believe that for the return of the present year we must allow at least seven days' duration; for when I first detected it on the evening of the 26th it had already attained considerable intensity. And the relative numbers counted on the 26th and 28th prove the decline to have been more rapid than the rise, so that had observations been possible before moonrise on the early evenings of the 24th and 25th, the shower would have been duly recognised, gaining intensity each night until it afterwards culminated in the brilliant maximum of November 27.

Bristol: 1885, *Dec.* 8.

La grande pluie des étoiles filantes du 27 Novembre 1885.
By F. Denza.

(*Communicated by the Secretaries.*)

La pluie extraordinaire des étoiles filantes du 27 Novembre 1872 s'est renouvelée cette année le même jour et à peu près avec la même intensité. D'après les télégrammes et les relations que nous avons reçus en grand nombre jusqu'à présent, il résulte que le phénomène en question a été remarqué dans toute l'Italie depuis les Alpes jusqu'à l'extrémité de la Sicile, et qu'il se produisit partout sous les mêmes formes. Il commença à la tombée du jour. A Tarente à 5^h du soir les étoiles jaillissaient et filaient en lignes si compactes, qu'elles perçaient de temps en temps l'obscurité déjà avancée de la nuit. A Palerme quelques-uns de nos anciens élèves ingénieurs comptérent 4600 météores de 5^h 15 à 6^h 30. A cette heure la pluie météorique se manifestait en plusieurs autres endroits avec une abondance tout à fait surprenante.

Dans notre Observatoire on commença à explorer le ciel à 6^h du soir (temps moyen de Rome). Nous avons suivi la même méthode que je suivis en 1872; les observations actuelles peuvent en conséquence être comparables avec celles d'alors. Comme j'eus déjà plusieurs fois l'occasion d'exposer cette méthode, je crois à propos de l'omettre ici. Je me bornerai à rapporter les résultats obtenus de 15 en 15 minutes, et afin de mieux éclaircir ma relation, je vais donner ci-dessous un tableau dont la seconde colonne indique le nombre des observateurs chaque quart d'heure; et la troisième l'état de l'atmosphère en dixième de ciel libre. La quatrième colonne contient le nombre des météores réellement comptés, et la dernière le nombre supputé des étoiles, c.-à.-d. le nombre qu'on aurait dû avoir par conjecture si les observateurs eussent été toujours au nombre de quatre et que le ciel eût été toujours serein.

Durée de l'observation.	Nombre des observateurs.	Dixièmes de ciel découvert.	Nombre des météores. Observé.	Calculé.
6 0 à 6 15	2	10	2800	5600
6 15 6 30	2	10	3100	6200
6 30 6 45	$2\frac{1}{5}$	10	3400	6200
6 45 7 0	3	10	4500	6000
7 0 7 15	4	10	6200	6200
7 15 7 30	4	7	3500	5000
7 30 7 45	$3\frac{1}{2}$	7	3100	4900
7 45 8 0	4	7	3200	4600
8 0 8 15	4	7	3100	4400
8 15 8 30	4	7	1700	2400
8 30 8 45	4	6	1500	2500
8 45 9 0	4	5	1000	2000
9 0 9 15	4	5	800	1600
9 15 9 30	4	4	600	1500
9 30 9 45	4	4	500	1200
9 45 10 0	3	3	234	1000
10 0 10 8	4	3	312	1000
Heures ... 4 8			39546	62300

Le ciel fut obscurci à 10^h 8 par un épais brouillard, qui le déroba à nos yeux tout le reste de la nuit. Ailleurs aussi des noires vapeurs voilèrent le ciel à la même heure et même avant. Seulement dans quelques localités de montagne et du midi, où le ciel se conserva serein jusqu'à l'heure la plus reculée de la nuit on affirma d'un commun accord qu'à 11^h le phénomène était presque fini. Les observations que nous avons faites dans les deux soirées suivantes du 28 et du 29 nous conduisirent à un résultat identique.

En 1872 nous en eûmes 33000 dans l'espace de six heures ; cette fois-ci, quoique les observateurs ne fussent pas toujours au nombre de quatre comme à cette époque, nous en avons compté 39000.

En 1872 l'abondance des étoiles atteignit son maximum entre 7^h 45 et 8^h 15 ; cette année au contraire le maximum avait eu déjà son commencement, quand le phénomène prit à paraître, ainsi que le prouvent les nombres calculés à Moncalieri dans les deux premières heures, lesquels sont presque constants. Beaucoup ont assuré que dès la nuit du 26 au 27 on vit une grande foule de météores sillonner les airs; ici le ciel était chargé. Les observations des régions orientales répandront plus de lumière sur ce sujet.

En 1872 nous étions toujours au nombre de quatre observateurs et nous comptâmes 18600 étoiles filantes pendant les deux heures proches du maximum, tandis que cette fois-ci dans

le même temps et presque toujours au nombre de deux ou de trois nous sommes parvenus à la chiffre imposante de 29500. Nous nous hâtons cependant de dire que toutes ces chiffres ne donnent qu'une estimation approximative de l'apparition, puisque pendant ces deux heures on ne comptait guère chaque météore, mais les groupes des étoiles seulement (et pas même tous), qui se succédaient presque sans interruption.

Par conséquent les résultats obtenus dans ce temps ne représentent que la cinquième ou la sixième partie, et peut-être sont-ils inférieurs au réel.

Je crois donc ne pas m'abuser en assurant que le nombre des étoiles apparues dans le temps de nos observations n'a pas été au-dessous de 150 à 160 mille. Le spectacle qui s'offrit à nos yeux pendant les deux premières heures du maximum était surprenant, et tel qu'on trouverait de la peine à le decrire. De toutes les parties du ciel il pleuvait des masses d'étoiles semblables à des nuages cosmiques qui se fondaient. Elles étaient suivies de traces lumineuses, et beaucoup de ces étoiles surpassaient celles de la première grandeur; quelques-unes même étaient de véritables bolides. La marche était en général haute, et la couleur prédominante était le rouge, tant à Moncalieri qu'ailleurs, occasionnée par les nombreuses vapeurs éparses dans l'atmosphère. Les météores qui se trouvaient le plus près des régions irradiantes étaient très-courts; aussi plusieurs n'étaient-ils que de points flamboyants par loi de prospective.

La plus grande partie jaillissait de la région même dont elles irradiaient en 1872, et laquelle se trouve entre *Cassiopée*, *Persée*, et *Andromède*.

On ne distinguait aucun centre secondaire comme dans les soirées ordinaires de la plus grande affluence.

Je mis tous mes soins à déterminer exclusivement la position du radiant, ce qui ne présentait aucune difficulté. Voilà de quelle manière je m'y pris. Je fixai attentivement sa position approximative et ensuite je traçai sur le papier le chemin de quelques-uns de ces météores qui se détachaient autour de ce point. J'achevai de cette façon 190 trajectoires, dont chacune à son tour en représente une infinité d'autres, qui suivaient le même chemin. En partageant ces trajectoires en trois groupes, j'ai obtenu les trois positions suivantes :—

		Radiant	
	h m		
A	7 35	$\alpha = 22^\circ$	$\delta = +44^\circ$
	8 20	$\alpha = 26$	$\delta = +43$
	9 8	$\alpha = 28$	$\delta = +42$

Ces points sont compris entre ϕ et γ d'*Andromède*, et le troisiéme point est tout près de cette dernière étoile.

Mon savant collègue M. Schiaparelli eut pour résultat :—

		Radiant	
	h m		
A	6 35	$\alpha = 15^\circ$	$\delta = +45^\circ$
	7 12	$\alpha = 18{\cdot}5$	$\delta = +44$
	8 7	$\alpha = 23$	$\delta = +42$

En conclusion, la grande quantité de météores observés de ces jours est la même que l'ont vit en 1859 et en 1872; elle se présente avec un intervalle de 13 ans, qui correspond à la double période de la comète Biela-Gambart, avec laquelle cet essaim météorique a des relations immédiates.

De l'Observatoire de Moncalieri:
2 *Déc.* 1885.

Observations and Orbit of the Meteor Shower of 1885, *November* 27. By G. L. Tupman.

The meteors were first seen at about six o'clock, when they were falling very fast, three or four appearing simultaneously. Sitting at a north window my wife counted 300 meteors between $6^h\ 33^m$ and $6^h\ 45^m$, about one-third of which were bright, and many with trains which lasted a few seconds. The sky then clouded over. It cleared again about eight o'clock, when I went out and began to count, keeping the radiant point in the centre of the sphere of vision. With occasional interruptions from passing clouds, the following numbers were obtained:—

h m	h m			
8 13·0	to 8 20·0	...	100, or 14	per minute.
8 20·5	8 31·0	...	100, 10	,,
8 48·5	8 58·0	...	63, 7	,,
8 59·0	9 8·0	...	73, 8	,,
9 10·0	9 15·0	...	45, 9	,,

The sky then became permanently overcast, but at $10^h\ 30^m$, in an opening low down in the east, they were still falling fast.

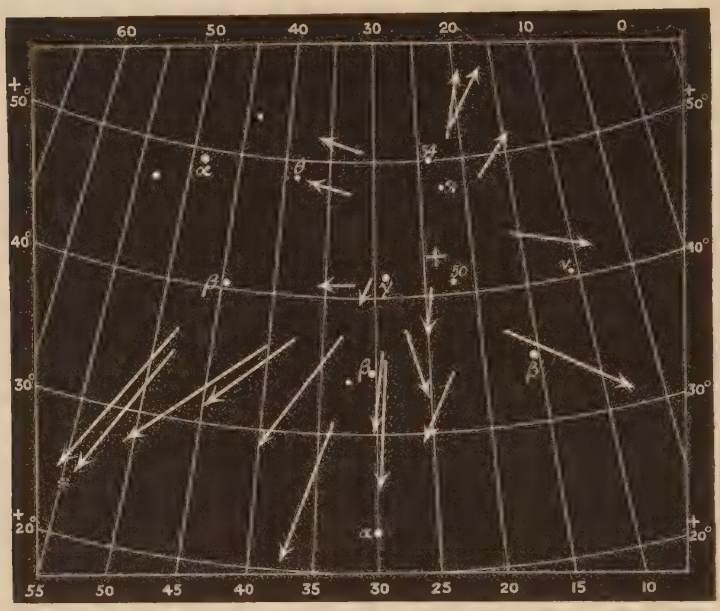
From $8^h\ 14^m$ to $8^h\ 31^m$, from the same window, my wife counted 150. In those seventeen minutes I had counted 200 in the open air. It is, therefore, reasonable to suppose that an observer in the open air, between $6^h\ 33^m$ and $6^h\ 45^m$, would have seen 400 meteors, or 33 per minute.

The brighter ones were of about the 1st magnitude—a few as bright as *Jupiter* or *Venus*. Many left streaks which endured two or three seconds. I only saw two or three brilliant enough to be called fireballs.

At first, instead of mapping tracks, I carefully watched for greatly foreshortened paths in the immediate neighbourhood of the radiant. About one half, perhaps, of them radiated from a

point midway between γ and 51 *Andromedæ*, in R.A. 27°, $\delta + 44°$; but nothing was more remarkable than the fact that the other half did *not* radiate from that point. The tracks of many characteristic *Andromedes*, when carried mentally backwards, did not pass within 10° of it.

Meteor Paths, 1885, *Nov.* 27, *observed at Harrow.*



The position of the *Cometary* Radiant is shown thus +.

During the latter part of the watch I mapped twenty tracks, as shown on the accompanying cut, selecting those which admitted of being pretty accurately reproduced as to direction and general position. The clouds interrupted this work, but the paths mapped are very instructive as to the nature of the radiation. Radiation from $22°\frac{1}{2} + 45°\frac{1}{2}$ is sharply indicated. On the chart the theoretical radiant point proper to particles of Biela's Comet, using the orbit of 1852,* viz. $23°{\cdot}5 + 43°{\cdot}0$, is indicated by a small cross. That is certainly not the point anyone would have fixed upon as the central position of the meteoric radiant. It falls, indeed, on the preceding limit of the radiant area. It is, perhaps, proper to mention that all the meteors moved slowly, in comparison with other showers. They were all white, except one which was a vivid red. One bright one stopped suddenly, became very much brighter; was stationary for about a second, then vanished.

On November 28, I watched for more than half an hour, about

* Corrected for Precession.

seven o'clock, with a perfectly clear sky, but only saw two *Andromedes*, no others.

The combination of the observations of this shower in 1872 and 1885 furnishes material for a calculation of the elements of the orbit without the necessity of assuming the mean distance to be the same as that of Biela's Comet. The only assumption I shall make is that, in the interval of thirteen years, the nucleus of the stream has made two complete revolutions.

In 1872, the maximum density of the shower was observed about November 27, 6^h G.M.T. On the present occasion the maximum would appear to have been about 5^h or 6^h G.M.T. The interval is 4748·0 mean solar days, and consequently the periodic time is 2374·0 days with very small error, corresponding to a mean distance of 3·4828.

The radius vector being common to both orbits (neglecting the dimensions of the Earth), the ratio of the orbital velocity of the meteors to that of the Earth is 1·30137 : 1.

The radiant points in the following table were determined with as much precision as is possible in such observations: -

	I. Nov. 26, 10^h	II. Nov. 27, 6^h	III. Nov. 27, 6^h	IV. Nov. 28, 9^h	V. Nov. 30, 7^h
Denning ...	26°·7 + 43°·5	24° + 43°·5	23° + 45°	22° + 43°·5	21° + 42°·5
Tupman (9^h)		27 + 44	22·5 + 45·5		

These positions and the mean distance and ratio of velocities above give the following orbits. The time of perihelion passage is shown for comparison with the presumed time of perihelion passage of Biela's Comet:—

P.P.	I. Dec. $27^d·9$	II. Dec. $27^d·8$	III. Dec. $26^d·7$	IV. Dec. $26^d·7$	V. Dec. $27^d·0$	Biela's Comet (A) Oct. 31?
Ω... ...	244°·9	245°·7	245°·7	246°·8	248°·8	246°·3
π... ...	112·2	111·1	109·2	108·2	107·3	109·6
i	13·1	13·0	13·6	12·5	11·6	12·6
ϵ	·7556	·7532	·7508	·7470	·7432	·7559
q	·851	·860	·868	·881	·895	·861
$2a-q$ ...	6·114	6·106	6·097	6·085	6·071	6·191
Motion ...	D	D	D	D	D	D

Andromeda Meteors. By J. Rand Capron.

The display to which attention was drawn by circular from Dun Echt took place on the 27th, but earlier in the evening than was anticipated. It commenced soon after dusk and lasted till 9 P.M., when clouds and rain prevented further observations. Ten time records were taken at intervals at Guildown, and three other local ones have been communicated to me. At times the stars fell almost continuously, and occasionally three or four at

a time. As the result of actual countings of portions of the sky, the estimated general rate for all parts was found to be as follows :—

P.M.	Per minute.	P.M.	Per minute.
6	10	8·30	25
7·20	22	9·0	26
7·50	29		

A few of the observations when the shower was thickest gave forty to fifty per minute.

Except for a short interval about 7.30, there was always cloud and mist to some degree, so that the countings and estimates are possibly under the mark. The estimated proportion of large meteors was 1 in 10. These were white, with long yellow, or reddish-yellow trails, and three to four times the size and brightness of *Jupiter*. The intermediate ones in size were also white. The smaller stars often appeared of a bluish and some of a yellow, or yellow-red tint. A considerable proportion of the meteors were referred to the radiant point, but frequently they were scattered all over the sky, and not so easily traced. At intervals they seemed more numerous in particular quarters, notably E. and W., and two observers to different points would differ considerably in their countings. The numbers observed overhead did not seem larger than elsewhere. At 9 P.M. on the 28th three large ones were observed.

Table of Observations of Andromeda Meteors, November 27, 1885, *at Guildown, and two other places.**

Time. P.M.	State of weather.	Obs.	Time of Counting. m	No. observed.	Direction.
6	Partly thick	C.	5	25	N.
6	„	L.	¼	5	N.
7	Much wind. Some seen through clouds				
7.20	Clear	W.	1	11	S. & W.
*7.30	„ ... ... (South Hill)	B^1.	10	74	N.E.
7.40	„	P.	10	107	S. & W.
	10 larger ones in 67				
7.45	Clear	B^2.	1	25	N.
7.50	„	P.	5	73	S.
7.50	Clouded	C.	5	12	N.
	Included several large ones				
8.0	Clearing, but part clouded ...	P.	10	68	N.E.
8.5	„ „ ...	B^2.	1	25	E.
*8.15	„ „ (Shere)	E. C.	1	20	?
8·30	„ „ ...	P.	10	126	W.
9	„ „ ...	C. & P.	5	65	W. & E.

Guildown: 1885, *Nov.* 28.

Meteor Shower connected with Biela's Comet. By the Rev. S. J. Perry, F.R.S.

The evening of November 27 was unfortunately cloudy at Stonyhurst, but it was cloudless until past midnight on the following day, and three observers kept a close watch for the meteors from 9.30 to 11.30, two of them remaining until 2 A.M. Fifty meteors were recorded, nine or ten of which radiated from the point R. 24°, δ +41°, and three other radiants in *Cygnus*, *Perseus*, and *Taurus*, were each fairly marked by four or five meteors. Those from *Andromeda* were of the 3rd or 4th magnitude, and were nearly all seen from 10.35 to 10.47, and from 12.20 to 12.27.

A note just to hand from Malta, gives the following account of the observations made of the meteor stream on the 27th, at St. Julian's Bay, by the Rev. J. Scoles, S.J., director of the Observatory.

"There was a fine display of meteors last night (27th), beginning as soon as dusk set in, attaining a maximum apparently about 7 P.M., and still continuing at 10 P.M. Radiant point very distinct in *Andromeda*, R.A. 21°, N.P.D. 46° approximately. Some of the trails very bright, and remaining visible in some cases for half a minute afterwards. Many were visible for a quarter of a minute. The uniformity of velocity in groups was very remarkable."

Stonyhurst Observatory:
1885, *Dec.* 8.

Notes on the Meteorites of November 27, 1885, as seen at East Tisted Rectory, Alton, Hants. By Rev. F. Howlett.

A few hours in anticipation of the time indicated in the notice so opportunely published by Dr. Copeland of Lord Crawford's Observatory at Dun Echt, the expected flight of meteorites so mysteriously connected with the orbit of the vanished comet of Biela was seen here for a limited time in great magnificence from about 6^h to 7^h 15^m on Friday evening, November 27, whilst the sky was fairly free from clouds.

The meteorites appeared in such multitudes, in greater or less frequency, that it was simply hopeless for any single observer to attempt correctly to count them, as they radiated from near γ *Andromedæ*, as was predicted, to all parts of the heavens, but chiefly, as it seemed to me, affecting the regions contiguous to *Pegasus*, *Cygnus*, and *Hercules*; though this impression may have been only illusory, and dependent upon the circumstance that the sky was generally clearer in those quarters than in others.

I should certainly say that, though perhaps on the whole not

so brilliant as were the *Leonids* of November 13–14, 1866, yet that they were decidedly more numerous. For whilst with the aid of one assistant, at the date just mentioned, I was enabled to estimate their apparition during the eight minutes (only) of the richest part of the shower, at 200 per minute, from $1^h\ 2^m$ to $1^h\ 10^m$ A.M. (see *Report of British Association* for 1867, p. 390), I should say that continuously almost, from 6^h to 7^h P.M. on Friday last, they were relatively fully 250 per minute.

A few that burst into view very close to γ *Andromedæ* appeared, as would necessarily be the case, almost if not quite stationary, but presenting sometimes a mass of luminous vapour fully half a degree sometimes in extent. All were of a white colour, and many left trains behind them for a few seconds of a ruddy and greenish hue. Unfortunately, after $7^h\ 15^m$ P.M., the sky became almost completely obscured by clouds and mist, though about 8 P.M. I could still perceive, through some partial breaks in the vapours, that the glorious pageant was still proceeding.

Watching for about a quarter of an hour on the following evening, November 28, with a perfectly clear sky from about 6^h to $6^h\ 15^m$ I only saw three meteors—of which the largest, equal in brilliancy to a star of the 1st magnitude, shot from near ε *Arietis* to a point midway between *Alpherat* and *Algenib*, quite another radiant therefore from that of November 27.

I imagine my estimate of the numbers seen on the day last mentioned will be questioned by some observers, but none the less should I maintain my opinion respecting them.

Meteoric Display, November 27, 1885.
By Colonel M. F. Ward.

The sky at the time had light clouds towards the south, but was intensely clear, and became suddenly alive with meteors falling to all points of the horizon from the small star χ *Andromedæ* (Proctor's map), with a slow motion, giving very much the idea of flakes of snow falling in a dead calm.

Some were very minute—barely visible—others as large as *Jupiter* or *Venus*. The latter travelled rapidly, leaving luminous streaks in their path, lasting in some cases more than half a minute—long enough to trace their direction to the above-named star.

Great numbers—and these of considerable size but of slow motion—came into view within a degree or two only of the horizon.

After 7.30 they diminished gradually in number. The sky clouded from 8 to 9.30, but the meteors were still seen in the intervals between the clouds.

At 9.30, sky again cloudless. Meteors still falling, though

in diminished numbers, on all sides. At midnight there were only occasional ones, and these chiefly in the west.

At first counting was quite impossible, but at 6.25 I was able to count, in one minute, between the N. and N.W. points, 104 meteors, my daughter counting 60 in the opposite quarter, and another 39 from the radiating point, in the same time (radiates).

At 10 P.M. I counted from that point 20, at 11 P.M. 7, and at midnight two meteors.

I have seen nothing like it since 1866.

Partenkirchen, Bavaria:

5.45 p.m. local time (44 m. fast of Greenwich). Lat. 47·30 N.; long. 11·5 E.

The Meteoric Shower as seen at Clapham on the night of November 27, 1885. By E. J. Spitta.

Observations were commenced at 6.10 P.M., and from that time until the clouds gathered, at 7 P.M., a careful watch was kept, and 660 meteors noted. As a matter of fact, I think the numbers should be 600 for the first 40 minutes, and 60 for the last 10, as the weather became thick at that time, and only the larger meteors could be seen and counted. Doing this, we have an average of about one in every four seconds.

Watch was again kept at 10.15, but few were then seen, and at 10.40 the clouds again gathered, and it commenced to rain.

Nearly all the meteors were small, about the 3rd or 4th magnitude, excepting a few which were larger, about equal to stars of the 1st magnitude, and two especially large ones, which rivalled *Jupiter* at opposition.

Speaking generally, very few left any train or sparks behind them; but, on the other hand, nearly all brightened up considerably before extinction.

With respect to colour: the heads were nearly all of a yellowish-white, but the larger type were pale blue. The two large ones before referred to as being so very bright, exhibited a decided bluish-white colour, like the magnesium balloons. These two left decided trains behind them, which had a tendency to redness, but they did not appear to last very long, although the meteors themselves travelled much slower than the rest.

No sound was heard of any kind during the whole time of observation, although such was carefully listened for.

The generality of the meteors did not last more than a second or a second and a half, but at the time of observation they were falling so quickly that it is difficult to make any definite statement.

Most of them indicated a starting-point somewhere near γ *Andromedæ*, but others a point nearer *Algol*, or 51 *Andromedæ*.

The path described in arc of most of the meteors was very

short; indeed, a great many appeared as if they were coming directly at the observer. But still a great many extended long lengths, some to the south, more to the east, but the most by far towards the north. Of the two large ones before referred to, one passed southwards, the other in a direction north-eastwards.

For the purpose of further investigation, I turned the 10-inch reflector on to a point near γ *Andromedæ*, a friend continuing the counting meanwhile, and I was lucky enough to see a small meteor cross the field in a few moments. Its passage appeared extremely rapid. Its colour was bluish-white rather than yellow, and it left not a vestige of a tail or a solitary spark.

The comparison of the shower this year and of that in 1872 may be said to be as follows:—

The meteors are much the same in size; if anything a trifle smaller.

The absence of tails of any great length in either years. The colours exhibited nearly similar.

Neither in this year nor in 1872 did the meteors extend to any great lengths of arc.

The numbers counted about the same, and the shower, comparatively speaking, over by 10.30, or thereabouts.

The radiant point seemed to extend itself towards *Cassiopeia* and *Perseus* as the evening wore on.

Ivy House, Clapham Common, S.W.:
1885, *Dec.* 10.

Addition to the Ephemeris for Physical Observations of Mars, 1886.
By A. Marth.

The Zero-Meridian, adopted in the ephemeris on p. 29 ff. will pass the centre of the disc of *Mars* at the following Greenwich Mean Times:—

1886	h m	1886	h m	1886	h m
Jan. 7	2 30·8	Jan. 19	10 5·9	Jan. 31	17 33·6
8	3 9·0	20	10 43·5	Feb. 1	18 10·5
9	3 47·1	21	11 21·1	2	18 47·3
10	4 25·2	22	11 58·6	3	19 24·1
11	5 3·2	23	12 36·1	4	20 0·8
12	5 41·2	24	13 13·5	5	20 37·5
13	6 19·2	25	13 50·8	6	21 14·1
14	6 57·1	26	14 28·1	7	21 50·7
15	7 35·0	27	15 5·3	8	22 27·2
16	8 12·8	28	15 42·4	9	23 3·6
17	8 50·6	29	16 19·5	10	23 40·0
18	9 28·3	30	16 56·6	12	0 16·4

1886	h m	1886	h m	1886	h m
Feb. 13	0 52·7	Mar. 27	1 21·1	May 8	2 54·6
14	1 28·9	28	1 57·3	9	3 33·1
15	2 5·0	29	2 33·6	10	4 11·6
16	2 41·1	30	3 10·0	11	4 50·2
17	3 17·2	31	3 46·4	12	5 28·8
18	3 53·2	Apr. 1	4 22·9	13	6 7·4
19	4 29·2	2	4 59·4	14	6 46·1
20	5 5·1	3	5 36·0	15	7 24·8
21	5 41·0	4	6 12·7	16	8 3·6
22	6 16·8	5	6 49·4	17	8 42·4
23	6 52·6	6	7 26·2	18	9 21·2
24	7 28·4	7	8 3·0	19	10 0·1
25	8 4·2	8	8 39·9	20	10 39·0
26	8 39·9	9	9 16·9	21	11 17·9
27	9 15·6	10	9 53·9	22	11 56·9
28	9 51·2	11	10 31·0	23	12 35·9
Mar. 1	10 26·8	12	11 8·1	24	13 14·9
2	11 2·4	13	11 45·3	25	13 54·0
3	11 38·0	14	12 22·6	26	14 33·1
4	12 13·6	15	12 59·9	27	15 12·2
5	12 49·2	16	13 37·3	28	15 51·3
6	13 24·8	17	14 14·8	29	16 30·5
7	14 0·4	18	14 52·3	30	17 9·7
8	14 36·0	19	15 29·9	31	17 48·9
9	15 11·6	20	16 7·5	June 1	18 28·2
10	15 47·2	21	16 45·2	2	19 7·5
11	16 22·8	22	17 22·9	3	19 46·8
12	16 58·5	23	18 0·6	4	20 26·1
13	17 34·2	24	18 38·4	5	21 5·5
14	18 9·9	25	19 16·3	6	21 44·9
15	18 45·6	26	19 54·2	7	22 24·3
16	19 21·3	27	20 32·2	8	23 3·7
17	19 57·1	28	21 10·2	9	23 43·2
18	20 32·9	29	21 48·3	11	0 22·7
19	21 8·8	30	22 26·5	12	1 2·2
20	21 44·7	May 1	23 4·7	13	1 41·7
21	22 20·6	2	23 42·9	14	2 21·3
22	22 56·6	4	0 31·1	15	3 0·9
23	23 32·7	5	0 59·4	16	3 40·5
25	0 8·8	6	1 37·8	17	4 20·1
26	0 44·9	7	2 16·2	18	4 59·8

1886	h m	1886	h m	1886	h m
June 19	5 40·4	June 23	8 18·2	June 27	10 57·3
20	6 19·1	24	8 57·9	28	11 37·1
21	6 58·8	25	9 37·7	29	12 16·9
22	7 38·5	26	10 17·5	30	12 56·8

Ephemeris of the Satellites of Uranus, 1886. By A. Marth.

P, angle of position of the minor axes of the apparent orbits.
a, b, major and minor semi-axes of the apparent orbits.
$u-U$, longitudes of the satellites in their orbits, reckoned from the points which are in superior conjunction with the planet or in opposition to the Earth.
$U+180°$, planetocentric longitude of the Earth reckoned in the assumed plane of the orbits from the ascending node on the celestial equator.
B, planetocentric latitude of the Earth above the plane of the orbits, the ascending node N and inclination J to the equator of 1880·0 are assumed to have the values

$$N = 165°{\cdot}770, \qquad J = 75°{\cdot}210.$$

Greenwich Noon	*Ariel.* P	a_1	b_1	u_1-U	Diff.	*Umbriel.* a_2	b_2	u_2-U	Diff.
1886	°	″	″	°	°	″	″	°	°
Jan. 13	284·96	14·67	+ 5·35	50·41	1428·47	20·43	+ 7·46	161·93	868·75
23	284·97	14·80	5·39	38·88	·45	20·62	7·50	310·68	·73
Feb. 2	284·99	14·92	5·40	27·33	·42	20·79	7·52	99·41	·72
12	285·01	15·03	5·38	15·75	·39	20·94	7·49	248·13	·69
22	·04	15·12	5·34	4·14	·36	21·07	7·44	36·82	·67
Mar. 4	·07	15·19	5·27	352·50	·34	21·17	7·35	185·49	·65
14	·11	15·24	5·19	340·84	·31	21·23	7·23	334·14	·63
24	285·14	15·26	+ 5·09	329·15	·29	21·26	+ 7·09	122·47	·62
April 3	·17	15·26	4·98	317·44	·26	21·25	6·94	271·39	·61
13	·20	15·22	4·87	305·70	·25	21·21	6·78	60·00	·60
23	·22	15·17	4·75	293·95	·23	21·13	6·62	208·60	·60
May 3	·24	15·09	4·64	282·18	·23	21·02	6·47	357·20	·60
13	·26	14·99	4·55	270·41	·22	20·88	6·33	145·80	·60
23	·27	14·88	4·46	258·63	1428·22	20·72	6·22	294·40	868·60
June 2	285·27	14·75	+ 4·40	246·85		20·55	+ 6·13	83·00	

		Titania.				*Oberon.*				
		a_3	b_3	u_3-U	Diff.	a_4	b_4	u_4-U	U	B
1886		"	"	°	°	"	"	°	°	°
Jan.	13	33·51	+12·23	181·70		44·82	+16·36	76·22	3·28	+21·41
					413·53					
	23	33·81	12·31	235·23	·52	45·22	16·46	343·62	3·30	21·35
Feb.	2	34·10	12·33	288·75	·50	45·60	16·49	251·01	3·33	21·20
	12	34·35	12·29	342·25	·49	45·93	16·44	158·39	3·37	20·96
	22	34·56	12·20	35·74	·48	46·21	16·31	65·75	3·42	20·66
Mar.	4	34·72	12·05	89·22	·46	46·43	16·11	333·09	3·48	20·30
	14	34·83	11·86	142·68	·45	46·58	15·86	240·43	3·54	19·90
	24	34·87	+11·63	196·13	·45	46·64	+15·55	147·76	3·60	+19·48
April	3	34·86	11·38	249·58	·44	46·62	15·22	55·09	3·67	19·05
	13	34·79	11·12	303·02	·44	46·52	14·87	322·42	3·73	18·64
	23	34·66	10·86	356·46	·45	46·34	14·52	229·75	3·78	18·26
May	3	34·47	10·61	49·91	·45	46·10	14·19	137·09	3·83	17·93
	13	34·25	10·39	103·36	·46	45·80	13·89	44·43	3·86	17·66
	23	33·99	10·20	156·82		45·46	13·64	311·78	3·88	17·46
					413·46					
June	2	33·71	+10·05	210·28		45·08	+13·44	219·14	3·89	+17·34

The values of P, a, b, and $u-U$ are to be interpolated for the times for which the apparent positions of the satellites are required, the equation of light being already taken into account. The position-angles p and distances s are then found by means of the equations

$$s \sin (p-P) = a \sin (u-U),$$
$$s \cos (p-P) = b \cos (u-U).$$

The satellites move in the direction of *in*creasing position-angles, and will be at their greatest elongations, and at their conjunctions with the centre of the planet, at the following Greenwich Mean Times :—

Ariel.

1886	N.	S.		N.	S.		N.	S.
$p=$	P+90°	P−90°						
	h	h		h	h		h	h
Feb. 2	10·5	3 16·8	Mar. 7	4·9	8 11·2	Apr. 11	11·8	12 18·0
4	23·0	6 5·3	9	17·4	10 23·6	14	0·2	15 6·5
7	11·5	8 17·7	12	5·8	13 12·1	16	12·7	17 19·0
10	0·0	11 6·2	14	18·3	16 0·6	19	1·2	20 7·5
12	12·5	13 18·7	17	6·8	18 13·1	21	13·7	22 20·0
15	1·0	16 7·2	19	19·3	21 1·6	24	6·2	25 8·5
17	13·4	18 19·7	22	7·8	23 14·1	26	14·7	27 21·0
20	1·9	21 8·2	24	20·3	26 2·5	29	3·2	30 9·5
22	14·4	23 20·7	27	8·8	28 15·0	May 1	15·7	2 22·0
25	2·9	26 9·2	29	21·3	31 3·5	4	4·2	5 10·4
27	15·4	28 21·6	Apr. 1	9·8	2 16·0	6	16·7	7 22·9
Mar. 2	3·9	3 10·1	3	22·3	5 4·5	9	4·2	10 11·4
4	16·4	5 22·6	6	10·8	7 17·0	11	17·7	12 23·9
			8	23·3	10 5·5	14	6·2	15 12·4

Umbriel.

1886.	N. h	S. h		N. h	S. h		N. h	S. h
Feb. 6	0·9	8 2·6	Mar. 11	4·5	13 6·3	Apr. 13	8·3	15 10·0
10	4·3	12 6·0	15	8·0	17 9·7	17	11·8	19 13·5
14	7·8	16 9·5	19	11·5	21 13·2	21	15·2	23 17·0
18	11·2	20 13·0	23	14·9	25 16·7	25	18·7	27 20·4
22	14·7	24 16·4	27	18·4	29 20·1	29	22·2	M. 1 23·9
26	18·1	28 19·9	31	21·9	A. 2 23·6	May 4	1·6	6 3·4
Mar. 2	21·6	4 23·3	Apr. 5	1·3	7 3·1	8	5·1	10 6·8
7	1·1	9 2·8	9	4·8	11 6·6	12	8·6	14 10·3

Titania.

1886 $p=$	Super. Conj. P h		N. Elong. P+90° h		Infer. Conj. P÷180° h		S. Elong P−90° h
Jan. 26	0·4	Jan. 28	4·6	Jan. 30	8·9	Feb. 1	13·1
Feb. 3	17·4	Feb. 5	21·6	Feb. 8	1·8	10	6·1
12	10·3	14	14·5	16	18·8	18	23·0
21	3·3	23	7·5	25	11·7	27	16·0
Mar. 1	20·2	Mar. 4	0·5	Mar. 6	4·7	Mar. 8	8·9
10	13·2	12	17 4	14	21·7	17	1·9
19	6·1	21	10·4	23	14·6	25	18·9
27	23·1	30	3·4	Apr. 1	7·6	Apr. 3	11·9
Apr. 5	16·1	Apr. 7	20·3	10	0·6	12	4·8
14	9·1	16	13·3	18	17·6	20	21·8
23	2·1	25	6·3	27	10·5	29	14·8
May 1	19·0	May 3	23·3	May 6	3·5	May 8	7·8
10	12·0	12	16·2	14	20·5	17	0·7
19	5·0	21	9·2	23	13·5	25	17·7
27	21·9	30	2·2	June 1	6·4	June 3	10·7

Oberon.

1886	Super. Conj. h		N. Elong. h		Infer. Conj. h		S. Elong. h
Jan. 23	14·7	Jan. 26	23·5	Jan. 30	8·3	Feb. 2	17·0
Feb. 6	1·8	Feb. 9	10·6	Feb. 12	19·4	16	4·2
19	13·0	22	21·8	26	6·6	Mar. 1	15·4
Mar. 5	0·2	Mar. 8	8·9	Mar. 11	17·7	15	2·5
18	11·3	21	20·1	25	4·9	28	13·7
31	22·5	Apr. 4	7·3	Apr. 7	16·1	Apr. 11	0·9
Apr. 14	9·7	17	18·5	21	3·3	24	12·1
27	20·9	May 1	5·7	May 4	14·5	May 7	23·3
May 11	8·1	14	16·9	18	1·7	21	10·5
24	19·8	28	4·1	31	12·9	June 3	21·7